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Report 207

Geology of the Cat Lake–Pickle Lake Area

Districts of Kenora and Thunder Bay

By

R.P. Sage and F.W. Breaks

1982

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GEOLOGICAL MAP

(back pocket)

Map 2218 (coloured)—Cat Lake–Pickle Lake, Geological Compilation Series, Districts of Kenora and Thunder Bay.
Scale 1:253,440 or 1 inch to 4 miles.

CHARTS

(back pocket)

Chart A (coloured)— Figures 4, 6, 7, 8, and 10.

Chart B (coloured)—Figures 11, 13, and 17.

Chart C—Appendix A.

ABSTRACT

An area of approximately 34 965 km² bounded by 51°00′ to 52°30′N Latitude and 89°00′ to 92°00′W Longitude was geologically mapped at a scale of 1:126,720 (1 inch to 2 miles) with helicopter support. The rocks in the map-area are largely of Early Precambrian (Archean) age and lie within the Superior Province of the Canadian Shield. Segments of four structural and lithological blocks lie within the map-area boundaries.

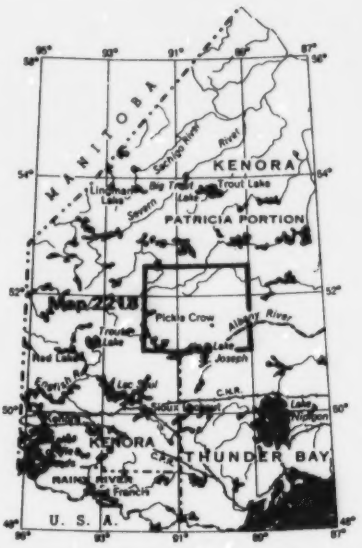

Figure 1–Key map showing location of Cat Lake–Pickle Lake area.

The Gods Lake Subprovince, the most northerly, covers approximately 30 percent of the map-area. This block consists of several east and southeast trending metavolcanic-metasedimentary belts separated by complex granitic terrain composed of migmatite and composite granitic stocks and batholiths. The belts are composed predominantly of mafic metavolcanics but metasedimentary units are present in all of the exposed belts. The Horseshoe Lake belt is intruded by a large mafic body and the Forester Lake belt contains ultramafic rocks.

The Cat Lake-Williams Lake Batholithic Complex separates the Gods Lake Subprovince from the Uchi Lake Subprovince and may be an eastward extension of the Berens River Subprovince. Within the limits of the map-area this possible extension of the Berens River Subprovince is sialic and consists of a complex series of composite granitic rocks, and batholiths. The rocks of this zone constitute approximately 20 percent of the map-area and commonly consist of porphyritic granodiorite to quartz monzonite.

The Uchi Lake Subprovince lies to the south of the Cat Lake-Williams Lake Batholithic Complex and consists of a series of bifurcating and anastomosing metavolcanic-metasedimentary belts separated and intruded by composite granitic stocks and batholiths. Approximately 40 percent of the map-area is underlain by rocks of the Uchi Lake Subprovince. The metavolcanic-metasedimentary belts within this block are predominantly mafic in composition but felsic metavolcanics are abundant in the Pickle Lake belt, Pashkokogan Lake-Misehkow River belt, Lake St. Joseph belt, Johnston Bay-Fry Lake belt, Meen Lake-Dempster Lake belt, and Lang Lake belt. Metasediments are abundant in the Lang Lake belt, Bamaji Lake-Fry Lake belt, Meen Lake-Dempster Lake belt, Lake St. Joseph belt, Johnston Bay-Fry Lake belt, and Pashkokogan Lake-Misehkow River belt. A thick zone of interbedded chert-magnetite and greywacke iron formation is located on the south shore of Lake St. Joseph and is of economic interest. Minor mafic to ultramafic intrusive bodies are locally present, but the largest and most significant occur within or marginal to the Lang Lake belt.

Felsic epizonal intrusions are not widespread but feldspar porphyry stocks occur in both the Bamaji Lake-Fry Lake belt and the Lang Lake belt. Two such quartz-feldspar porphyry stocks are located at Pickle Crow and perhaps may be associated with the gold mineralization of the area. The southwest end of the Bamaji Lake-Fry Lake belt has been intruded by a large complex intrusive body with some epizonal characteristics. This body contains molybdenite-bearing quartz veins and minor amounts of disseminated molybdenite occur within the rocks of the complex itself.

Rocks of the English River Subprovince consist of a monotonous sequence of biotite-quartz-plagioclase schists possibly representing the metamorphosed equivalents of a series of greywacke sediments. The rocks are most commonly of lower to middle amphibolitic facies rank of regional metamorphism but local sillimanite-bearing assemblages suggest the occurrence of rocks of upper amphibolite facies rank. Minor amounts of amphibolite are present and three prominent iron formations consisting of interbedded magnetite and biotite-quartz-plagioclase schist have been delineated.

Rocks of the four subprovinces are cut by the northwest-striking Pickle Crow Diabase dike of possible Late Precambrian (Keweenawan) age.

The entire map-area was covered by ice sheets during the last ice advance of Wisconsin age. The most notable Pleistocene feature resulting from this ice advance is the northwest-striking Agutua end moraine.

During the past 40 years the area has received periodic examination for gold, base metals, and iron deposits. At present the area remains active as a mineral exploration target. These efforts were rewarded by the copper-nickel-platinum group metals discovery of Union Miniere Explorations and Mining Corporation Limited, in the Pickle Lake area in 1971.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the

Cat Lake–Pickle Lake Area

Districts of Kenora, Patricia Portion, and Thunder Bay

by

R.P. Sage[1] and F.W. Breaks[1]

INTRODUCTION

"Operation Pickle Lake" was the seventh in a continuing series of helicopter-supported regional geological mapping projects. Mapping was done at a scale of 1 inch to 2 miles (1:126,720) of an area of approximately 34 965 km^2.

Geological reconnaissance mapping of the Cat Lake—Pickle Lake area, bounded by Longitudes 89°00′ to 92°00′W and Latitudes 51°00′ to 52°30′N, was undertaken with the aid of a helicopter from May 26 to September 15, 1972. A base camp was established at Pickle Lake.

Recent mapping in the area by Goodwin (1965) and Clifford (1969) for the Ontario Department of Mines has been completed in the Lake St. Joseph area. The entire project area had been previously mapped in a reconnaissance fashion at a scale of 1 inch to 4 miles (1:253,440) by the Geological Survey of Canada, (Carruthers 1961; Emslie 1960, 1962; Jackson 1961). This earlier mapping was part of the Roads to Resources Program of the Geological Survey of Canada and gave a broad general outline of the 'greenstone' belts and granite areas. The present program was undertaken to better define the belts and identify the lithologies present in more detail. Previous mapping was done in the Pickle Lake area, Bamaji Lake area, Pashkokogan Lake-Misehkow River area, and Windigo Lake area (Evans 1941; Thomson 1939; Harding 1936; Dyer 1934; Satterly 1941).

Method of Mapping

The map-area was traversed by helicopter from base camp at Pickle Lake or from helicopter fly camps of short duration established at Bamaji Lake, Cat

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Lake, Mawley Lake and Menako Lake. The helicopter flight lines were spaced about 4.8 to 6.4 km apart with stops spaced at approximately every 3 to 5 km. Some modification of the flight path was made to account for the variable distribution of outcrop and its relative accessibility with the helicopter. A closer spacing of flight lines was made along the metavolcanic-granite contacts. In addition to providing uniform geologic coverage, helicopter stops were also selected to interpret aeromagnetic trends and anomalies.

Data from outcrop examinations were recorded on acetate overlays of 1 inch to 1 mile (1:63 360) air photos. In addition to recording the geology at the outcrops visited, an attempt was made to generalize outcrop areas.

Geologic data from the helicopter work along with previous data were then transferred to a 1 inch to 2 miles (1:126 720) scale cronoflex base map supplied by the Cartography Section, Lands and Waters Group, Ontario Ministry of Natural Resources. These data were combined with aeromagnetic data and used to outline a follow-up ground program in the most desirable areas. Ground work consisted mostly of lakeshore and river work and limited ground traversing in selected areas.

The mineral showings indicated on the map are combined from data on file in the Assessment Files Research Office, Ontario Geological Survey, government reports, findings of this survey, and the records supplied to members of this project by various mineral exploration companies.

Preliminary maps (Sage *et al.* 1973a, b, c, d) were published after the field season, without the benefit of laboratory results. Upon receipt of laboratory data the geology and interpretation were modified accordingly and incorporated in the revised preliminary maps P.806, 807, 808, 809.

The final coloured map (Map 2218, back pocket), part of the Geological Compilation Series, has been issued at a scale of 1 inch to 4 miles (1:253,440). Additional detail for previously unmapped metavolcanic-metasedimentary belts is given on coloured charts A and B (back pocket) at a scale of 1:125 000.

Acknowledgments

The mapping program for Operation Pickle Lake was coordinated and supervised by R.P. Sage, F.W. Breaks, and W.R. Troup. G. Stott, G. McWilliams, P. Bowen, S. d'Apollonia, R. Neils, and P. Atherton ably served as senior mapping assistants. D. Robertson and G. Jordan worked as senior mapping assistants under direct supervision of G. Stott for most of the summer. J. Goring, D. Stone, D. Meloche, R. Barrett, G. Hobbs, J. Lafond, M. Goodwin and E. Ronayne served ably as junior geological assistants.

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The sections of this report dealing with the general geology of the Upper Windigo Lake belt, Horseshoe Lake belt, Forester Lake belt, and Wigwascence Lake belt, were written by Glen McWilliams, senior geological assistant who mapped these respective belts. Gregg Stott, senior geological assistant, wrote the sections of this report dealing with the general geology of the Lake St. Joseph belt, Bamaji Lake-Fry Lake belt, and Johnston Bay-Fry Lake belt. These sections have been edited by the senior authors. The senior author (R. Sage) prepared the descriptions of the remaining metavolcanic-metasedimentary belts and Pleistocene geology, and F. Breaks prepared the sections on economic geology, the English River Subprovince, and granitic rocks.

W.R. Cowan of the Engineering and Terrain Geology Section reviewed the Pleistocene geology section of this report.

Access

Access to Pickle Lake is by Highway 599, approximately 300 km north of its junction with Highway 17 at Ignace. Bus transport is available from Harasym's Transportation Limited which has a weekly service from Thunder Bay and a daily service connecting with the Canadian National Railway's Transcontinental at Savant Lake. Hookers Air Services Limited runs a daily flight to Dryden from Monday through Friday, and on Saturday, Severn Enterprises Limited has a weekly flight from Thunder Bay.

To the north of Pickle Lake a gravel access road is being built which at the time of writing, was available for travel as far as Upper Windigo Lake. Ultimately it is anticipated that this road will link up with Red Lake.

Access to the area surrounding Pickle Lake is by float equipped aircraft which can be chartered in Pickle Lake, Armstrong, Sioux Lookout, Ignace, or Red Lake.

Topography

The area is generally characterized by flat to low undulating terrain with local relief rarely exceeding 60 m. Sinuous esker ridges and drumlin-like hills

of gravel and sand form the most conspicuous topographic relief. A small hill just north of the townsite of Pickle Lake rises several hundred feet above the surrounding land surfaces, and serves as a prominent navigational aid to flyers in the area. Vast areas in the northern and eastern portions of the project area are covered with swamps, bogs and shallow lakes and streams.

Outcrop Distribution

Outcrop density within the map-area is highly variable. In the southwest corner of the map-area, outcrop is so abundant that individual outcrops could not be separated at the scale of mapping. Outcrop in the northeast corner of the map-area is practically nonexistent, hindering geological interpretation.

Forest Products

Extensive tracts of forested land are suitable for cutting of pulp wood, and some timber tracts are being logged for lumber for local consumption. Trees are predominantly black and white spruce, poplar, birch, and minor balsam and tamarack. The larger more developed trees generally grow on the well drained sand and gravel hills and ridges within the map-area.

Fish and Game

Commercial fishing is carried on by local residents for pickerel and lake trout. Northern pike is common to the area and attracts sport fishermen. Trapping of fur-bearing animals has in the past provided income for local residents, but is not a large income earner at present. Moose are very abundant in the southern portion of the project area and bear have been observed. Water fowl are common to the area, and bald eagles and blue herons are present, though uncommon.

Agriculture

Soil suitable for agricultural purposes does not exist in the area. Some local citizens have small garden plots for their personal use.

Weather

Weather statistics for the Pickle Lake area for the period 1941 to 1971 were obtained from the Atmospheric Environment Service, Toronto. The mean an-

nual rainfall is 479.6 mm, mean annual snowfall 2623.8 mm, total precipitation 731.5 mm; mean annual daily maximum 4.7°C, and mean annual daily minimum -6.5°C. Statistics on wind and speed were not available, but several flying days were lost due to high winds. During the 1972 field season snow fell on June 15 and July 2, and on September 15, the last day of the field season, 10 to 12 cm of wet snow was on the ground.

Mineral Resources

The immediate area of Pickle Lake has been known to be favourable for gold mineralization since the late 1920s. The operations of Central Patricia Gold Mines Limited and Pickle Crow Gold Mines Limited had a cumulative production of 64 731.87 kg of gold (Source Mineral Deposit Files, Geoscience Data Centre, Ontario Geological Survey) from 1934 to 1966. Active gold mining in the Pickle Lake area ceased with the closure of the Pickle Crow Mine in 1966.

Union Minière Explorations and Mining Corporation Limited was at the time of writing, developing a copper-nickel deposit[1] estimated to contain 9 000 000 tonnes of 1.6 percent copper and 0.2 percent nickel, approximately 11 km west of Pickle Lake (Canadian Mines Handbook 1972-73, p.330).

On the south shore of Lake St. Joseph, Steerola Exploration Company, a wholly owned subsidiary of Steep Rock Iron Mines Limited, has outlined a deposit of 590 million tonnes of magnetite-bearing taconite (Canadian Mines Handbook 1972-73, p.309).

Within the map-area the metavolcanic-metasedimentary belts contain numerous showings of gold, base metals, and iron. Exploration for economic mineral deposits over the past 40 years has been intensive. Currently and in the recent past, The International Nickel Company of Canada Limited, Selco Mining Corporation Limited, Cochenour Willans Gold Mines Limited, and Union Miniere Explorations and Mining Corporation Limited have all conducted extensive exploration programs to evaluate the mineral potential of the area.

The metavolcanic-metasedimentary belts are considered highly favourable for economic mineral deposits.

Inhabitants

Within the map-area the population is concentrated in three areas. A small settlement exists on IR 63C at Cat Lake and several hundred individuals reside at Osnaburgh IR 63B. Several hundred residents are located at Pickle Lake and the Central Patricia townsite. The former townsite of Pickle Crow is now abandoned. Development of the Union Miniere Explorations and Mining Corporation Limited Thierry copper-nickel deposit has stimulated an influx of workers who have settled predominantly in the Central Patricia area.

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[1]The Thierry mine was brought into production August 1976. In 1978, 921,663 tons were milled at an average grade of 1.29 percent copper (Canadian Mines Handbook 1979-80, p.280).

A Hudson's Bay Company store, two small general stores, two charter aircraft companies, a hotel, a construction-transportation company and an Ontario Ministry of Natural Resources base are located at Pickle Lake. A post office, grade school, and a fisheries plant (presently closed) are situated at Central Patricia. The Ontario Ministry of Natural Resources, charter aircraft companies, Hudson's Bay Company, and Kovals Brothers Limited provide most local employment. At Osnaburg IR 63B and Cat Lake, schools are operated by the Department of Indian Affairs. At Osnaburg House a nursing station is operated by the Department of National Health and Welfare. The residents of Cat Lake and Osnaburg IR 63B support themselves by commercial fishing, employment with the Ontario Ministry of Natural Resources at Pickle Lake, and by employment as bush workers with a number of exploration companies working in the area. At Stirland Lake a mission is operated by the Mennonite Church.

Severn Enterprises Limited operates a small float plane base on the east end of Mawley Lake. Approximately 110 km north of Central Patricia along the new Pickle Lake-Red Lake access road a dirt surfaced airstrip for wheel-equipped aircraft is operated by Hookers Air Service during the winter months. A similar facility is operated by Severn Enterprises Limited approximately 20 km southeast of Mawley Lake along the Pickle Lake-Red Lake road. Two dirt surfaced airstrips are located at Pickle Lake, one just south of Pickle Lake and the second just north of Central Patricia on the north side of the Kawinogans River.

GEOLOGICAL SUMMARY

The map-area lies within the Superior Province of the Canadian Shield. Most of the rocks are of Early Precambrian (Archean) age and form bifurcating and anastomosing folded belts of metavolcanic, metasedimentary and associated rocks separated and intruded by composite granitic stocks and batholiths. Figure 2 illustrates the generalized geology of the area, location of the metavolcanic-metasedimentary belts described in this report, and structural subprovinces as interpreted by the authors. Table 1 summarizes the lithologic units and the geological succession of the map-area.

Rocks included within the Gods Lake Subprovince (Figure 2) are found in the northern portion of the map-area and cover approximately 30 percent of the area. Within the map boundaries, all or part of three metasedimentary-metavolcanic sequences are present and the migmatized remains of two others are interpreted to be present. The belts have an east and southeast trend and are narrower in width and generally more poorly exposed than the belts within the Uchi Lake Subprovince. The rocks are dominantly mafic to intermediate in composition with minor thin intercalated horizons of felsic to intermediate metavolcanics. Quartz-feldspar porphyry dikes are locally present. Within the Upper Windigo Lake belt, greywacke and greywacke conglomerates form a horizon located along the central axis of the belt. Along the north margin of the Forester Lake belt, a poorly defined belt of metasediments of upper amphibolite grade of regional metamorphism has been delineated. These metasediments are the southeastern extension of the metasediments found in the North Cari-

TABLE 1 | TABLE OF LITHOLOGIC UNITS FOR THE CAT LAKE — PICKLE LAKE AREA

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Till, sand, gravel, boulders, clay

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

Diabase dikes (Keweenawan?)

Intrusive contact

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

Diorite, gabbro, anorthosite, gabbroic anorthosite

Intrusive contact

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

LATE TECTONIC GRANITIC PLUTONS

Monzonite, quartz monzonite, granodiorite, syenodiorite, quartz diorite, trondhjemite, pegmatite, aplite

Intrusive contact

SYNTECTONIC GRANITIC PLUTONS

Migmatite, orthogneiss, trondhjemite, granodiorite, diorite, quartz diorite

Intrusive contact

PRETECTONIC GRANITIC PLUTONS

Quartz and/or quartz-feldspar porphyry, trondhjemite to granodiorite (Bamaji Lake complex)

Intrusive contact and gradational contacts

MIGMATITE

Metasedimentary and metavolcanic migmatites

Intrusive contact

MAFIC TO INTERMEDIATE INTRUSIVE ROCKS

Gabbro, diorite, anorthosite, anorthositic gabbro

Intrusive contact

METAVOLCANICS AND METASEDIMENTS

METASEDIMENTS[1]

Conglomerate, greywacke, quartzite, siltstone, argillite, slate, biotite-quartz-plagioclase schist

Gradational contact

FELSIC TO INTERMEDIATE METAVOLCANICS[1]

Flows, pyroclastic breccia, agglomerate and tuff, porphyritic flows; rhyolite, dacite

Gradational contact

MAFIC TO INTERMEDIATE METAVOLCANICS[1]

Flows, pillowed flows, tuff; basalt, andesite

1 Age relations between metasediments, mafic metavolcanics, and felsic metavolcanics are variable.

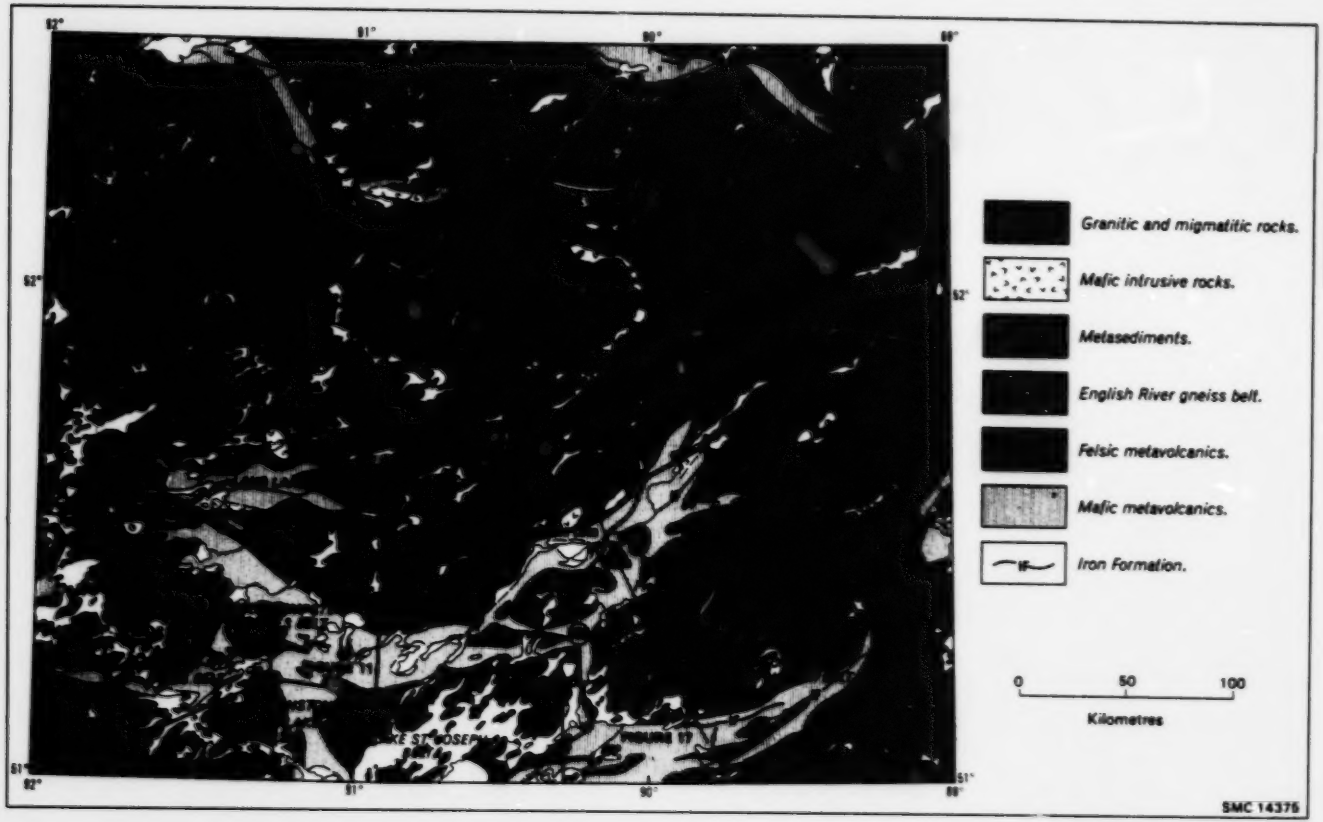


Figure 2–Generalized geology of the Cat Lake–Pickle Lake area, showing location of metavolcanic-metasedimentary belts described in the report, and outlines of 1:125,000-scale geological maps (Charts A and B, back pocket) of previously unmapped metavolcanic-metasedimentary belts.

bou-Opapimiskan Lake area (Satterley 1941; Thurston *et al.* 1979). In the Horseshoe Lake belt, a quartz-rich metasedimentary unit, approximately 0.4 km thick, occurs along the north margin of a large mafic intrusive body. These quartz-rich metasediments are associated with a sequence of mafic metavolcanics and are considered to be generally similar to those reported by Donaldson and Jackson (1965) for the North Spirit Lake area.

The exposed western portion of the Horseshoe Lake belt is dominated by a large mafic intrusive body of gabbro-diorite composition. Some of the more massive and coarser grained outcrops in the Forester Lake belt, which have been mapped as thick flow centres, may also be intrusive. Of particular note, in the southwest corner of the Forester Lake belt, are ultramafic rocks of uncertain classification (i.e. sills or flows) intercalated with mafic to intermediate metavolcanics. These rocks may be extrusive and perhaps similar to ultramafic flow rocks reported by Viljoen and Viljoen (1969) occurring at the base of the Barberton Mountain sequence in South Africa.

Prominent linear magnetic anomalies in the Upper Windigo Lake belt, Horseshoe Lake belt, and Forester Lake belt indicate minor amounts of iron formation.

Data for a valid structural interpretation for the above three "greenstone" belts are lacking but they are believed to be synclinal.

On Wigwascence Lake and striking northwest from Totogan Creek, aeromagnetic data (ODM-GSC 1970a, b) and very limited outcrop suggest the presence of former metavolcanic-metasedimentary belts which are interpreted as migmatized remnants.

The Cat Lake-Williams Lake Batholithic Complex is predominantly sialic and separates the Gods Lake Subprovince from the Uchi Lake Subprovince. This extensive mass is believed to be in fault contact with the Gods Lake Subprovince and the Uchi Lake Subprovince, (Wilson 1971; Riley *et al.* 1971) but evidence for these fault zones was not observed by the present survey. Within the map-area the batholithic complex forms an east-striking granitic mass approximately 30 km in width at the western boundary and which terminates at approximately 89°55'W Longitude. The strike length of this granitic mass within the map-area is approximately 140 km and its general shape is interpreted from aeromagnetic data (ODM-GSC 1970a, b). The complex is characterized by erratic swarms of locally oblate, node shaped aeromagnetic patterns representing late granitic intrusions of Early Precambrian age (ODM-GSC 1970a, b). The complex covers about 20 percent of the map-area and may represent an eastern extension of the Berens River Subprovince. Helicopter mapping of this area has disclosed a complex assemblage of granitic rock types. These rocks are predominantly granodiorite and quartz monzonite with equigranular to porphyritic, medium to coarse grained textures. A small but variable magnetite content within the granitic rocks gives the erratic but distinctive aeromagnetic pattern for the area.

The Uchi Lake Subprovince was named the Red Lake Block by Wilson (1971), and Riley *et al.* (1971) referred to this same subprovince as the Uchi Lake belt. Within the boundaries of the map-area this subprovince consists of a series of bifurcating and anastomosing metavolcanic-metasedimentary belts intruded and separated by composite granitic stocks and batholiths. Rocks lying within the Uchi Lake Subprovince constitute approximately 40 percent of

the map-area. The rocks within the metavolcanic-metasedimentary belts of the subprovince are predominantly mafic to intermediate metavolcanics which are often pillowed. Felsic to intermediate metavolcanic, pyroclastic and/or flow rocks almost exclusively of dacitic composition occur within the Meen Lake-Dempster Lake belt, Lang Lake belt, Lake St. Joseph belt, Pickle Lake belt, Pashkokogan Lake-Misehkow River belt, and minor occurrences are present in the Dempster-Pickle Lakes belt, and at Dempster Lake in the Meen-Dempster Lakes belt. The complete volcanic cycle described by Wilson (1971, p.43-45) as one of the characteristics of this block is present in a number of the belts, but areas of possible multicycle volcanism have not been clearly defined. Sampling of the volcanic rocks by the authors for total rock chemistry was restricted to identification and classification by the methods of Irvine and Baragar (1971); AFM diagrams and normative plagioclase vs. Al_2O_3 plots are shown in Figures 3a, b, c, d. Phenocrysts were not removed from porphyritic volcanic rocks before analysis. The AFM plot of the metavolcanics indicates that approximately one-third are tholeiitic and the remainder are calc-alkaline.

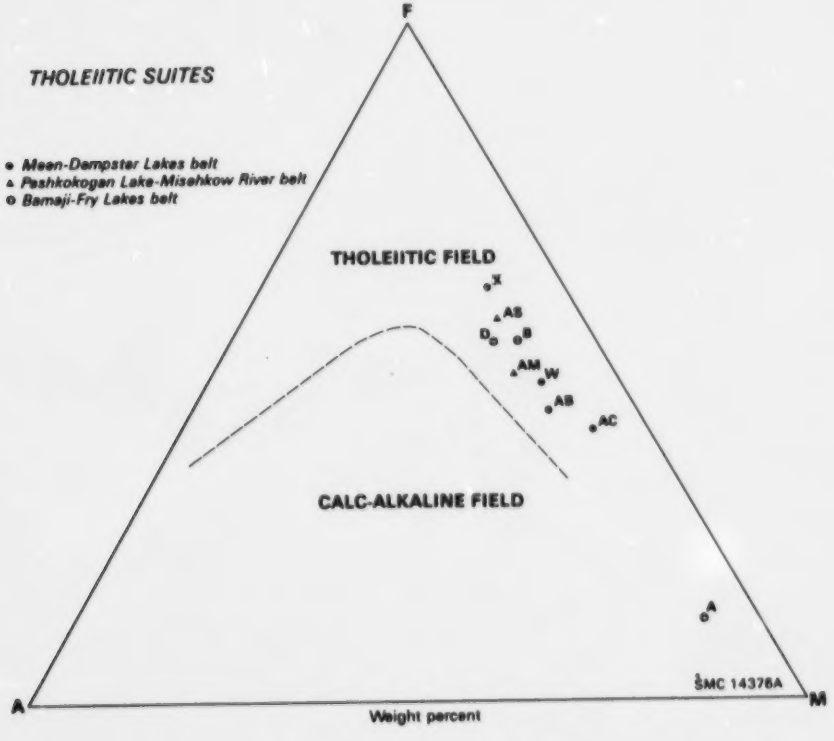


Figure 3a–AFM diagram of tholeiitic suite of volcanic rocks from the Uchi Lake Subprovince, Cat Lake–Pickle Lake area. Sample numbers refer to Appendix A (Chart C, back pocket).

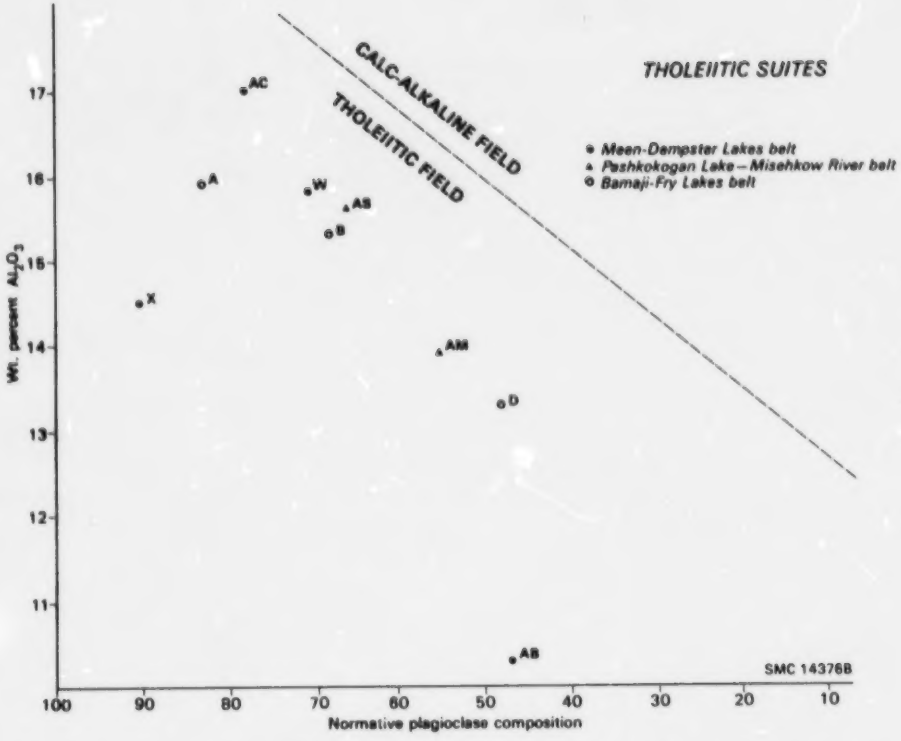


Figure 3b–Al_2O_3 versus normative plagioclase composition for the tholeiitic suite of volcanic rocks from the Uchi Lake Subprovince, Cat Lake–Pickle Lake area. Sample numbers refer to Appendix A (Chart C, back pocket).

Metasediments are common throughout the Uchi Lake Subprovince. The metasediments are dominantly greywacke in composition but arkosic, argillaceous, and conglomeratic units are present. Between the Meen Lake-Dempster Lake belt and the Bamaji-Fry Lakes belt greywacke forms a major unit. Of particular note within the metasediments of the Uchi Lake Subprovince are sillimanite in the metasediments north of Bamaji Lake, granitic boulders in a conglomeratic unit exposed on Billett Lake, and a unit of arkosic cherty limestone on Jacknife Lake. The presence of the granitoid boulders on Billett Lake would confirm Wilson's (1971) observation and inference that granitic terrains were exposed during the latter phase of 'greenstone' belt development even though most conglomerate within the map-area consists of clastic material from a volcanic source area. A sequence of metasediments of predominantly greywacke composition is locally well exposed on Lake St. Joseph, in particular along the south shore of the lake. These rocks have, at least locally, well developed porphyroblasts of staurolite and andalusite. Sillimanite porphyroblasts were also

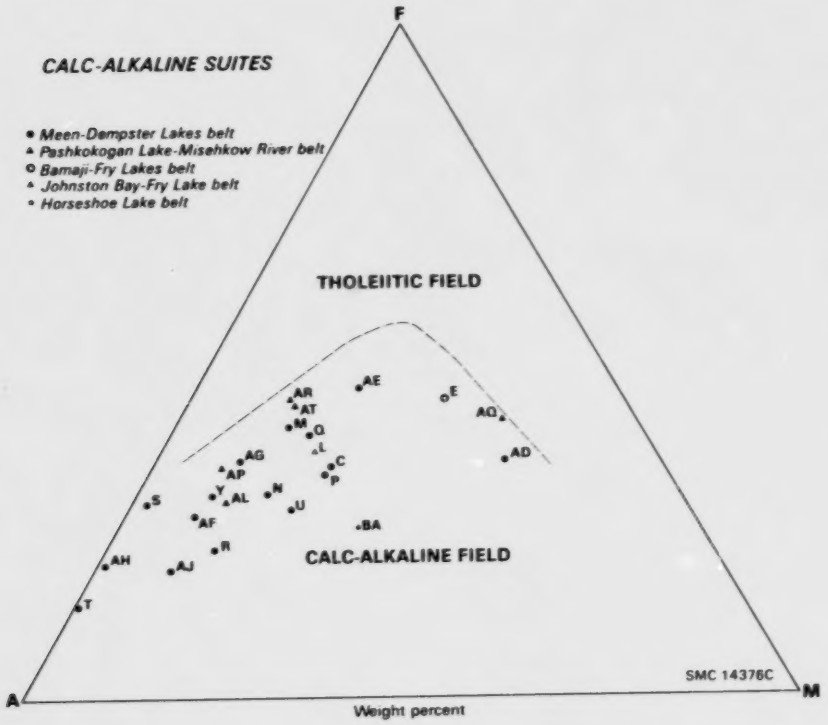


Figure 3c–AFM diagram of calc-alkaline suite of volcanic rocks of the Cat Lake–Pickle Lake area. All but one sample belong to the Uchi Lake Subprovince. Sample numbers refer to Appendix A (Chart C, back pocket).

noted at a water control dam site at the extreme eastern end of the lake (Osnaburg Lake-Pickle Lake belt). Conglomeratic, argillaceous, and arkosic strata are also present within this belt. In the Pashkokogan Lake-Misehkow River belt poorly exposed greywacke and argillaceous metasediments occur at Pashkokogan Lake, Iron Falls and north of Pashkokogan Lake. An extensive metasedimentary sequence consisting of greywacke, conglomerate, arkose, and argillite is present in the eastern quarter of the Lang Lake belt. Several southwest-trending metasedimentary units project southwest from the Dempster-Pickle Lakes belt. A particularly good exposure of conglomerate composed of clastic volcanic debris is located within one of these units on Wincott Lake. Numerous minor occurrences of metasediments intercalated and interdigitating with the metavolcanics are found throughout the subprovince. A minor occurrence of conglomerate on the south end of Bamaji Lake is of particular note since it may be a remnant of a basal conglomerate between the metavolcanics of the belt and former granitic basement rocks.

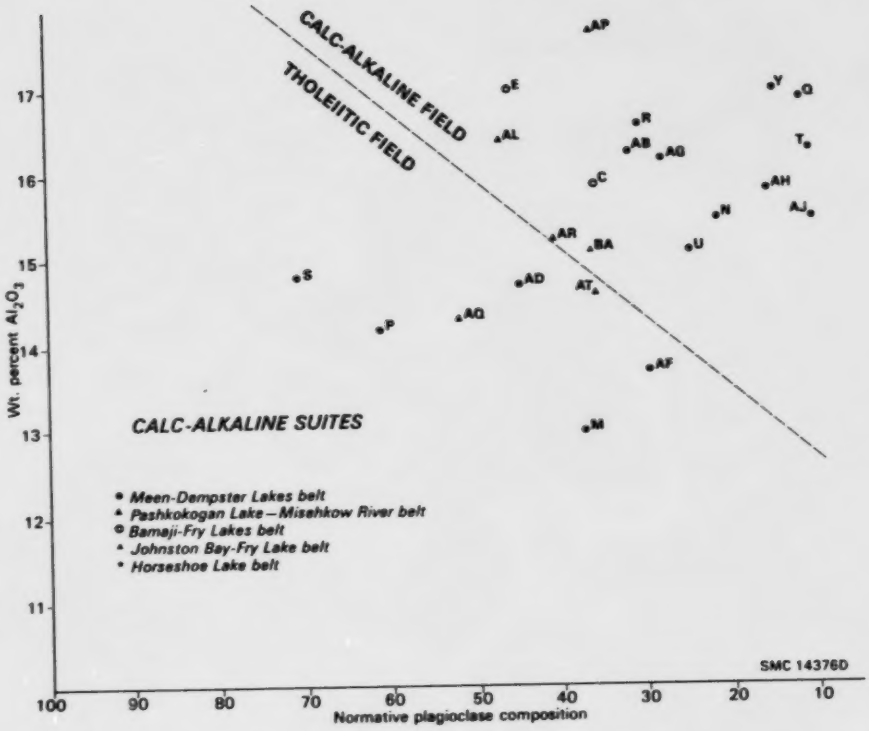


Figure 3d–Al_2O_3 versus normative plagioclase composition for the calc-alkaline suite of volcanic rocks of the Cat Lake–Pickle Lake area. All but one sample belong to the Uchi Lake Subprovince. Sample numbers refer to Appendix A (Chart C, back pocket).

Iron formation is common throughout all the metavolcanic-metasedimentary belts. Gold mineralization in association with iron formation occurs at Pickle Crow in the Pickle Lake belt and has been of economic importance to that area. At Lake St. Joseph an extensive deposit of interbedded chert-magnetite and greywacke may have significant economic influence on future development in the area. Just north of Iron Falls on the Misehkow River within the Pashkokogan Lake-Misehkow River belt a unit of banded chert-magnetite iron formation occurs beneath the river bed.

Mafic to ultramafic intrusions are widespread throughout the Uchi Lake Subprovince but with the exception of the gabbroic intrusions within the Lang Lake belt, they do not at any one place form a major lithologic unit. A small ultramafic-mafic body occurs on a small unnamed lake approximately 6.4 km west of the south end of Senior Lake, and a small peridotite body occurs at the south end of an unnamed lake approximately 0.4 km east of Kawashe Lake. In a road cut at Rat Rapids on Highway 599 a 15 m wide peridotite body is exposed.

Subvolcanic felsic intrusions are not common in the map-area. The most impressive intrusive body of epizonal characteristics is the molybdenite-bearing Bamaji Lake complex within the Bamaji-Fry Lakes belt. This body varies from quartz monzonite to trondhjemite in composition and contains molybdenite in quartz veins and as disseminations in the rocks. A feldspar porphyry plug is present on the south side of Bajami-Fry Lakes belt, and a northwest-southeast elongated, subvolcanic quartz-feldspar porphyry intrusion or flow is present southeast of Relyea Lake in the Meen-Dempster Lakes belt. In the Pickle Lake belt several quartz-feldspar porphyry bodies intrude the metavolcanics between Central Patricia and Pickle Crow. Some of the felsic units mapped as volcanic within the Meen-Dempster Lakes belt may be shallow subvolcanic sill-like intrusions. Within the Lang Lake belt a small feldspar porphyry stock is present on Shonia Lake.

Granitic stocks cut the metavolcanic-metasedimentary sequence in a number of places. The Kawashe Lake and Graniteboss Lake stocks cut the rocks of the Meen-Dempster Lakes belt and the Duffell Lake stock cuts the Dempster-Pickle Lakes belt. Within the Pickle Lake belt are the Pickle Lake stock and Hooker-Burkoski stock. The Pashkokogan Lake-Misehkow River belt is cut by the Webb Lake stock, and numerous granitic stocks occur in the Lake St. Joseph belt, the largest and most notable being the Doran Lake stock.

The metavolcanic-metasedimentary belts are dominantly of greenschist facies grade of regional metamorphism, enveloped in rocks metamorphosed to the amphibolite facies. Some recrystallization of the cataclastic rocks marginal to the belts has occurred. These cataclastic rocks could be products of dynamic metamorphism as suggested by Wilson (1971, p.43). Exposure close to the granitic stocks is insufficient to determine whether contact metamorphic effects occurred concomittant with emplacement of the stocks.

The dominant structure of the belts is synclinal but anticlinal structures are present on the north side of the Bamaji-Fry Lakes belt, within the Pickle Lake belt, and at the eastern end of the Lake St. Joseph belt.

One particularly important observation made during this operation is the almost ubiquitous occurrence of cataclastic textures in the granitic rocks marginal to the 'greenstone' belts. These textures vary in the degree of development from those with strained quartz and fractured mineral grains to protomylonites. The more developed textures appear to be in those trondhjemitic rocks that appear to be early to syntectonic rather than the later, more massive granodiorites and quartz monzonites. From thin section and field observations, belt margins appear to represent a complex interplay of tectonic and magmatic events.

Rocks lying within the English River Subprovince lie along the southern or southeast margin of the map-area and form approximately 10 percent of the map-area. The rocks of this subprovince are distinctly different from those of the other subprovinces.

Rocks of the English River Subprovince lying within the map-area consist of a monotonous sequence of biotite-quartz-plagioclase schists locally highly injected with white to pale pink granite and granite pegmatite. Sillimanite in absence of muscovite is common in some thin sections of English River rocks suggesting local occurrences of upper amphibolite grade of regional metamorphism. Aeromagnetic trends and limited outcrop data of the English River Subprovince indicate the presence of three units of magnetic iron forma-

tion. These units are found to consist of magnetite layers interbedded with biotite-quartz-plagioclase schist of greywacke composition. Minor amounts of amphibolite of unknown parentage are also commonly associated with the iron formation. Coarse clastic metasediments are absent suggesting that the sediments were deposited at some considerable distance from this source.

The rocks are extensively cut by white to pale pink granitic rocks which may make up 20-30 percent by volume of the rocks of the English River Subprovince. The granitic rocks weather in relief giving the appearance of a greater abundance than actually exists. The granitic rocks occur as ramifying dikelets, *lit-par-lit* injections, and isolated bulbous masses approaching the size of small stocks. The granitic material may, in part, be anatectic.

Late to post-tectonic mafic rocks are scarce in the map-area and are exemplified by the Kibler Lake Stock.

One of the major geological features of the map-area is the Pickle Crow diabase dike. Pye (1952) considered this dike as Keweenawan (Late Precambrian) in age. The dike has a prominent aeromagnetic expression (ODM-GSC 1970a, b) and can be traced beyond the map-area southeastward towards Lake Nipigon, and northwestward to the vicinity of North Caribou Lake. The dike most likely cuts rocks of all the structural subprovinces in the map-area even though its aeromagnetic trend is somewhat obscure in the Cat Lake-Williams Lake Batholithic Complex. On Atikokiwam Lake along the Albany River and at Coles Lake along the south margin of the Pashkokogan Lake-Misehkow River belt, the dike is from 75 to 90 m wide. Pye (1952) reported comparable widths within the Pickle Lake belt in proximity to the Central Patricia-Pickle Crow area.

The map-area has undergone extensive glaciation and all sections are covered by glacial deposits. The glacial topography as seen today is, to a large degree, a function of the last Wisconsin ice advance and retreat (Prest 1963). The dominant Pleistocene feature is the Agutua end moraine and its associated fluvial and lacustrine deposits (Prest 1963). This morainal complex strikes southeast from Upper Windigo Lake in the northwest corner of the map-area to Snowflake Lake at the east margin of the map-area. In the Upper Windigo Lake area and south of Snowflake Lake within proximity to the Albany River, gravel and sand deposits of this morainal complex form hills 100 m or more in height. Drumlinoid hills, ground moraines and sinuous esker complexes many kilometres in length form most of the other Pleistocene features. Boulders of oolitic hematite left by the retreating ice sheets in the Lake St. Joseph area are thought to have their source somewhere in the Palaeozoic or Precambrian rocks northeast of the map-area. In hand specimen these boulders appear similar if not identical to the oolitic iron formations of the Sutton Lake area of northeastern Ontario described by Hawley (1926, p.21-25).

For the past 40 years the area has undergone extensive examination for mineral deposits. During the 1920s this prospecting was limited to gold deposits. More recently efforts have been concentrated on locating base metal deposits. These exploratory efforts were rewarded in 1971 with the discovery of the Thierry copper-nickel deposit of Union Miniere Explorations and Mining Corporation Limited at Kapkichi Lake within the Pickle Lake belt. Exploration for additional base metal deposits is currently proceeding within the project boundaries. The large iron deposits of the Lake St. Joseph belt should prove of

future economic importance. The metasediments and metavolcanics of the area are considered to be favourable hosts for gold and base metal mineralization. Some of the iron formation units offer a future potential as a source of iron.

EARLY PRECAMBRIAN

Metavolcanic-Metasedimentary Belts of the Gods Lake Subprovince

UPPER WINDIGO LAKE BELT

Upper Windigo Lake is located 150 km northwest of Pickle Lake, in the northwest corner of the map-area. Access at the time of mapping was limited to float plane, but access road 808 now reaches Upper Windigo Lake.

The area around Upper Windigo Lake is covered by sand and gravel of the Agutua moraine. This extensive cover limited ground traverses to the area northwest of Upper Windigo Lake and adjacent to the Windigo River. East of Upper Windigo Lake outcrops are nonexistent except for small exposures on Nango Lake. The extension of the belt south and east of Upper Windigo Lake is based on the geophysical interpretation of aeromagnetic map 897G (ODM-GSC 1960). Previous geological mapping of the belt was carried out by Satterley (1941) at a scale of 1 inch to 2 miles (1:126 720).

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics are the predominant lithologic unit of the belt and consist of foliated andesite to basalt, pillowed andesite to basalt, mafic tuff, layered amphibolite and metavolcanic migmatite. The greater part of this assemblage is made up of dark green foliated andesite to basalt which weathers grey-green. Several medium-grained massive units were encountered which represent either flow centres or sill-like intrusions. These massive flow centres or sills are dark green in colour on the fresh surface, and have a grey-green mottled appearance on the weathered surface. The colour index estimated from the weathered surface ranged from 25 to 40 with an estimated mean of 30. Few pillow lavas were observed, and where found, they were elongate and symmetrical with a mean length of 60 cm and width of 15 cm. Pillow top determinations indicated by Satterley (1941) could not be verified due to poor exposure.

Several small lens-shaped bodies of intermediate to mafic tuff and lapillistone (classification of Fisher 1961) outcrop north of the Windigo River. One of these bodies can be traced for 30 m along strike with a maximum exposed

thickness of 10 m. The tuff and lapillistone consist of stretched mafic fragments in a more felsic groundmass. Fragments range in size from fine ash up to 4 mm with a mean size of 1 mm.

Mafic to intermediate metavolcanics occurring as layered amphibolite, intrusive breccia, and injected and agmatic migmatite (Mehnert 1968) are found along the contact between the metavolcanic-metasedimentary belt and the surrounding granitic batholiths.

FELSIC METAVOLCANICS

The felsic metavolcanics indicated on Map 2218 were reported to the authors by geologists (personal communication) of Union Miniere Explorations and Mining Corporation Limited.

METASEDIMENTS

The metasediments occupy a narrow continuous unit along the northwest margin of the belt near the Windigo River and a narrow unit exposed on islands in Upper Windigo Lake. This lithologic group includes arkose, pebble and cobble conglomerates, and garnet-biotite-amphibole-quartz-feldspar schist and gneiss.

Fine- to medium-grained arkose occurs in beds up to 60 cm thick in biotite-chlorite-quartz-feldspar schist which represents former greywacke and argillite sequences. In thin section the arkose consists of stretched, polygonized quartz grains, plagioclase and chert fragments, all set in a fine-grained biotite-chlorite matrix.

Conglomerates are the best exposed members of the sedimentary succession. North of the Windigo River the chert pebble conglomerates are highly sheared with measured axial ratios of the long and short axis of the clasts up to 10:1. Length of the clasts vary from 1 cm to 30 cm with an estimated mean of 8 cm. Because of the intensity of tectonic movement only the chert clasts have been preserved. What appear to have been volcanic clasts have been crushed and are now almost indistinguishable from the matrix. Width of this conglomerate unit is in excess of 30 m. To the east on the islands in the centre of Upper Windigo Lake the clasts of the conglomerate are larger and less deformed. Here the clasts range in length from 5 cm to 45 cm. The composition of the clasts was visually estimated as 40 percent chert, 30 percent granitic, and 10 percent volcanic. The chert (containing up to 5 percent magnetite) clasts are well rounded ovoids with axial ratios of the long and short axis up to 2.5. The volcanic clasts are more highly deformed than the chert clasts and appear to be similar in composition to the surrounding mafic metavolcanics. The granitic clasts are typically medium grained, equigranular and leucocratic. The matrix of the conglomerate is greywacke, metamorphosed to a biotite-feldspar schist. The dip of the beds is nearly vertical. Decrease in the clast size to the west indicates an eastern source area.

Greywacke, as represented by biotite-quartz-feldspar schist, is found in two

localities on the north shore of Upper Windigo Lake. Primary structures have been obliterated by the intense deformation of these rocks.

IRON FORMATION

In the present survey iron formation was not observed in outcrop. Satterley (1941) who may have encountered lower lake levels indicated iron formation on two small islands on Upper Windigo Lake.

The presence of iron formation associated with the metasediments is indicated by linear magnetic highs on aeromagnetic maps 898G and 897G (ODM-GSC 1960). Strong local compass deviations were encountered while mapping in the field.

The major, geophysically interpreted, iron formation band is traceable for approximately 13 km roughly straddling Latitude 52°30'. Magnetic intensities range up to 70,000 gammas absolute field intensity. Several local iron formation units are also aeromagnetically evident in the Nango Lake area.

MIGMATITE

See "Structural Geology".

Structural Geology

The Upper Windigo Lake metavolcanic-metasedimentary belt is intensely deformed and complexly folded. Shearing and metamorphism have destroyed most of the primary volcanic and sedimentary structures. A well developed metamorphic foliation where discernible, is parallel to bedding, and produced by the subparallel orientation of amphiboles, chlorite, biotite, muscovite and the stretching of volcanic and sedimentary fragments and clasts.

Satterley (1941) suggested that pillow horizons flanking the two conglomerate bands implied that the metavolcanics represent a single horizon repeated by folding about an approximately east-west axis with the formation of at least two synforms and three antiforms. The curvilinear form of the conglomerate unit suggests that this tightly folded sequence was folded by the intrusion of the granitic batholith to the south of the metavolcanic-metasedimentary belt. The southern contact between the metavolcanic-metasedimentary belt and the granitic batholith is characterized by a broad migmatite zone. This migmatite zone occurs in the form of intrusion breccia, *lit-par-lit* injection, and large xenolithic blocks separated by granitic sills and dikes.

Economic Geology

Prospecting in this belt is greatly hampered by widespread glacial drift cover. Little record exists of any mineral exploration prior to the recent program of Union Miniere Explorations and Mining Corporation Limited (UMEX) (E. Reeve, UMEX, personal communication, 1972). Satterley (1941) mentioned that a staking rush was precipitated in 1928 by discovery of a gold-bearing pyrite-chalcopyrite-quartz vein on the southwest shoreline of Upper Windigo Lake. No significant mineralization was encountered by the present survey.

During 1973, airborne electromagnetic-magnetic surveys and follow-up ground geophysical surveys were carried out by UMEX (E. Reeve, personal communication).

HORSESHOE LAKE BELT

The Horseshoe Lake metavolcanic-metasedimentary belt is located 90 km north-northwest of Pickle Lake. Access to the area is by float plane or via Highway 808 from Pickle Lake to the Pipestone River (140 km) and thence by canoe or boat to Horseshoe Lake.

The Horseshoe Lake belt (Figure 4, Chart A, back pocket) consists of east-trending metavolcanic-metasedimentary and metagabbroic units bounded by granitic batholiths to the north and south. It can be traced for a distance of 35 km in an east-west direction and reaches a maximum width of 6 km. Previous geological mapping was done by the Geological Survey of Canada (Carruthers 1961). Rio Tinto Canadian Exploration Limited (Hall 1962) and Great Plains Development Company of Canada Limited (Sawyer 1971) have conducted mineral exploration programs in the area.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The mafic to intermediate metavolcanic assemblages in the Horseshoe Lake belt were mapped as massive to foliated andesite to basalt, pillowed andesite to basalt, layered amphibolite and migmatized mafic metavolcanics, in order of decreasing abundance. Colour of the weathered surface varies from light green to dark green and the darkening in the colour generally indicates an increase in the amphibole content although not necessarily an increase in the mafic content. On fresh surfaces colour varies from green to black. Characteristic mineral assemblages in order of decreasing mineral abundance include:

1) hornblende + plagioclase ± chlorite ± quartz ± epidote ± carbonate;
2) chlorite + plagioclase + quartz ± biotite ± magnetite ± actinolite;
3) plagioclase ± chlorite ± epidote ± quartz ± magnetite.

In general the mafic to intermediate metavolcanics are moderate to intensely foliated and massive varieties are rare.

Stretched pillow lavas are exposed at several locations along the shore of Horseshoe Lake. The pillows form crudely lenticular units ranging in size from 15 by 30 cm to 60 by 150 cm and are separated by dark green fine-grained chloritic selvedges which tend to weather low leaving the pillows standing in relief. Deformation prevented any reliable pillow top determinations.

Layered amphibolite and migmatized mafic to intermediate metavolcanics occur at several locations along the north and south contact of the belt with the granitic batholiths. Migmatite, which has developed marginally to the belt because of intrusion by the surrounding granitic rocks, is either in the form of agmatitic breccia or more commonly *lit-par-lit* injection.

FELSIC TO INTERMEDIATE METAVOLCANICS

Felsic to intermediate metavolcanics are not well exposed in the belt, and where present occur as narrow lenses up to 8 m in width, and 130 m in length. Felsic metavolcanics commonly weather white to buff but are light green to dark grey on fresh surfaces. In general shearing has produced a well defined foliation in the felsic metavolcanics and some units are locally schistose. Occurrences include narrow bands of tuff, lapilli tuff and flows within the mafic metavolcanics and metagabbro. Characteristic mineral assemblages of the felsic metavolcanics in order of decreasing mineral abundance include:

1) plagioclase + quartz ± microcline ± muscovite ± epidote;
2) plagioclase + quartz ± chlorite ± carbonate ± epidote.

Although the felsic metavolcanics are very minor in abundance at the present erosion level the common occurrence of felsic volcanic fragments within the metasediments suggests that these rock types may have been more widespread prior to the deposition of the sediments.

METASEDIMENTS

The metasediments form a discrete, narrow, linear unit along the northern boundary of the gabbroic pluton. This metasedimentary assemblage includes greywacke, argillite, arkose, quartzite and conglomerate in estimated order of abundance. This metasedimentary sequence, however, is incomplete due to the engulfing nature of the gabbroic intrusion. The metasediments are best exposed along the south shore of Horseshoe Lake, where 2 to 10 m wave washed cross-sections of this metasedimentary sequence are visible at low water levels during late summer and where the sequence reaches a maximum estimated width of 150 m.

Sandstones represented by feldspathic greywacke, quartz greywacke, arkose, feldspathic arkose and orthoquartzite have the following mineral assemblages in order of decreasing mineral abundance:

1) plagioclase + quartz + biotite ± muscovite ± magnetite;
2) quartz + plagioclase (andesine) + biotite ± muscovite ± magnetite;

3) plagioclase + quartz ± microcline ± biotite ± muscovite ± epidote;
4) quartz + (plagioclase) ± muscovite ± stilpnomelane ± chlorite ± magnetite;
5) quartz + (plagioclase) + carbonate ± zoisite.

On fresh surfaces these rocks are dark grey to green-grey and weather light grey to buff. The quartz content appears to increase with the grain size and varies from 10-90 percent with an estimated mean of 35 percent. These sandstones appear to be similar to the quartz-rich suite described by Donaldson and Jackson (1965) in the North Spirit Lake belt. These workers used the prefix *quartz* as an extension of Pettijohn's (1957) sandstone classification for greywackes which contain 75 percent quartz plus chert in the framework fraction in addition to more than 15 percent matrix. The abundance of quartz suggests either a quartz-rich source area or a higher maturity than is commonly associated with greywacke.

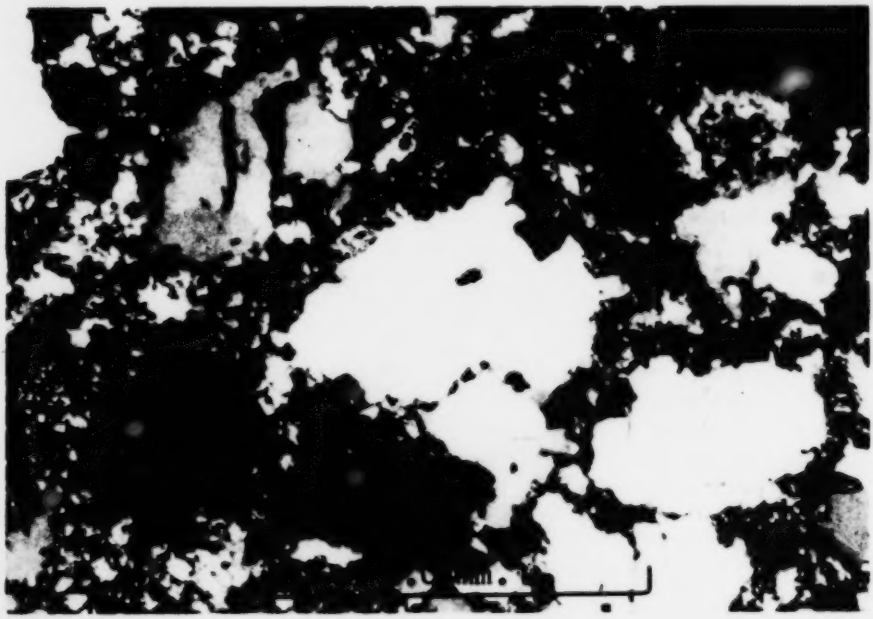
In the field the sandstones were classified as greywacke, arkose and quartzite. In general arkose and quartzite occur in massive structureless units which weather a light buff colour. Greywacke weathers a dark colour, and commonly occurs in graded beds interbedded with argillite. The matrix content of the greywacke was estimated to be less that 35 percent and commonly is around 20 percent. This may in part represent secondary alteration of former lithic fragments which are presently represented only by chert fragments. The framework of the sandstone consists of strained quartz and feldspar, angular to subangular, commonly separated by the matrix fraction (Photo 1). The high angularity of many of the grains may be consequent to crushing during folding of the belt and thus cannot be used as an index of maturity.

Argillite is interbedded with the sandstone in units of up to 9 m thick. Within these units are fine graded laminae which vary from 1.5 mm up to 13 mm in thickness (Photo 2).

These varve-like laminations represented by coarse to fine cycles commonly show graded bedding, cross laminations, and micro scour structures. In some areas they are presently represented by fissile shales and slates and contain porphyroblasts which are possibly andalusite. The characteristic metamorphic mineral assemblages in order of estimated decreasing abundance include:

1) muscovite + albite + quartz ± biotite ± carbonate ± opaques ± andalusite(?);
2) quartz + albite + muscovite ± biotite ± chlorite ± opaques.

Conglomerates are poorly represented in the Horseshoe Lake belt. Several lenses of immature pebble and cobble conglomerates are present. Bedding, if present, is indistinct. Clast size ranges from 10 cm to 1 mm. In addition to the apparent lack of sorting the clasts are angular in shape with the exception of rounded bombs and lapilli derived from contemporaneous volcanism. Clasts are generally randomly oriented but locally may define a weak foliation parallel to the bedding and regional trend. Most of the clasts within the conglomerate units were derived from the underlying siliceous sedimentary rocks. In addition, the conglomerates contain chert or lean iron formation and felsic volcanic fragments of lapilli and bomb sizes. The apparent absence of sorting,



OGS 10 258

Photo 1–Photomicrograph of quartzite from south shore of Horseshoe Lake. Strained quartz grains with secondary overgrowths, dispersed in a microcrystalline matrix of feldspar, carbonate and quartz, in order of increasing abundance.

bedding and abrasion of the clasts, in addition to the local extent of the conglomerates, suggest these are local laharic breccias or slump breccias associated with volcanism (Photo 3).

MAFIC INTRUSIVE ROCKS

The Horseshoe Lake belt contains a large mafic pluton which has intruded the metavolcanic-metasedimentary sequence. The intrusion of this body occurred prior to regional metamorphism and emplacement of the surrounding granitic batholiths. This mafic intrusion is well exposed, especially in the large burned over area south and west of Horseshoe Lake. The contact of the pluton south and east of Horseshoe Lake is covered by swamp and vegetation and the presence here of gabbroic rocks has been interpreted from aeromagnetic map 916G (ODM-GSC 1960).

The mafic pluton, generally gabbroic in composition, is dark green to green-black on the fresh surface and dark green to green-grey on the weathered

OGS 10 259

Photo 2–Finely laminated argillite from the south shore of Horseshoe Lake. Feldspathic laminations are bleached by etching with hydrofluoric acid.

surface. The gabbro contains minor quartz and lath shaped feldspars which are enclosed by finer grained mafic minerals. The mafic minerals hornblende, actinolite, chlorite and biotite are visually estimated to make up 55 percent of the rock.

In the field it is often difficult to distinguish between mafic intrusive rocks and coarse-grained interiors of flows. Criteria for distinguishing the two are as follows:

The mafic intrusive rocks (1) are coarser grained, (2) are less deformed, (3) are more massive, (4) often contain blue quartz eyes, (5) show chilling and intrusive relationships at contacts with adjacent metavolcanic-metasedimentary units, and (6) contain rafts of metasediments into which they have been intruded.

QUARTZ-FELDSPAR PORPHYRY

Three minor quartz-feldspar porphyry intrusions were found within the Horseshoe Lake belt. Along the south shore of the east-trending arm of Horseshoe Lake a 2.4 m wide quartz-feldspar porphyry dike intrudes the gabbro.

OGS 10 260

Photo 3–Poorly sorted laharic breccia or poorly sorted conglomerate of Horseshoe Lake belt. Feldspars have been etched white by hydrofluoric acid.

Quartz-feldspar porphyry also occurs south and east of the Pipestone River southwest of Nigras Lakes and was intersected by several diamond drill holes in the "Rose Lake" (local name) area (D.A. Sawyer, Great Plains Development Company of Canada Limited, personal communication, 1972).

These rocks are light grey on the fresh surface and weather to a light buff colour. Quartz and feldspar phenocrysts which visually are estimated to comprise 40 percent of the rock are subhedral to euhedral and vary in size from 1 mm to 25 mm. The dark coloured groundmass consists of biotite, fine grained quartz and feldspar, and carbonate in order of decreasing abundance.

The presence of a rusty shear zone adjacent to the quartz-feldspar porphyry on the south arm of Horseshoe Lake prompted the drilling of this dike by Rio Tinto Canadian Exploration Limited (Hall 1962).

Structural Geology

The metavolcanic-metasedimentary sequence of the Horseshoe Lake belt was intruded by an early mafic pluton, and subsequently these rocks were folded to a near vertical position. The mafic pluton and metavolcanic-metasedi-

mentary sequence have been intruded and migmatized along the margins of the belt by the surrounding granitic batholiths. A paucity of top determinations, scarcity of outcrop, lack of distinctive marker horizons, and disruptive nature of the mafic pluton renders it extremely difficult to unravel the structural history of the Horseshoe Lake belt. Shearing and metamorphism have destroyed most of the primary volcanic and sedimentary structures.

The regional trend of the schistosity as defined by subparallel orientation of biotite, chlorite and amphibole is east-west. This metamorphic foliation parallels the primary structures such as bedding and long axis of pillows where observed.

One observed major fault strikes east and forms the north contact of the belt with the granitic batholith. The direction of displacement of this fault could not be determined. Faulting post-dating intrusion of the granitic batholith is indicated by local mylonitization of granitic rocks adjacent to the fault. Other faults may occur but were not discovered due to the scarcity of outcrop.

The eastern termination of the belt is probably due to the truncation by a major fault system, evidence for which is based upon a linear aeromagnetic discontinuity (Map 926G, ODM-GSC 1960). This fault parallels a well defined regional set of southeasterly striking lineaments.

Economic Geology

During the survey several exposures of the massive gabbro pluton were noted to contain sporadic, disseminated to hairline fracture-fillings of chalcopyrite and/or pyrrhotite and/or pyrite mineralization often accompanied by malachite staining. Two grab samples of both disseminated and fracture controlled mineralization in addition to several specimens containing no observable sulphide mineralization were taken by the field party and submitted for assay to the Geoscience Laboratories. The results (Table 2) indicate that several of the apparently unmineralized gabbro specimens contain significant trace quantities of copper and nickel. Zinc and cobalt levels are relatively constant and typical for gabbroic rocks. The Geological Survey of Canada conducted a copper lithogeochemical survey which interestingly revealed several anomalously high copper values in the Horseshoe-Kecheokagan Lakes area (Carruthers and Holman 1964). These values which range from 26 to 300 ppm and average 175 ppm closely correspond to the position of the Horseshoe Lake gabbro pluton.

The results suggest that this gabbro complex is locally enriched in copper and nickel. Several mineralized occurrences were also encountered by Great Plains Development Company of Canada Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto), following their airborne INPUT[R] electromagnetic survey in 1971. In the northeast corner of claim PA 311182 massive pyrrhotite and pyrite (about 10 percent) occur along fracture surfaces within gabbro. This occurrence lies close to the map location of an airborne INPUT anomaly (Assessment Files Research Office). Further to the east on claim

[R]Registered trademark of Barringer Research Limited.

TABLE 2 TRACE METAL ANALYSES IN PARTS PER MILLION OF MINERALIZED AND UNMINERALIZED GABBRO GRAB SAMPLES FROM THE HORSESHOE LAKE BELT.

Sample Number	Copper	Nickel	Cobalt	Zinc	Silver	Gold
UNMINERALIZED						
HAH 7-10A[1]	390	50	40	N.D.	1	Trace
AH 7-29	140	80	40	N.D.	1	N.D.
AH 8-2	26	140	59	100	N.D.	N.D.
AH 8-16	86	160	50	91	N.D.	N.D.
AH 8-68	44	33	22	82	N.D.	N.D.
AH 8-74	100	110	45	N.D.	5	N.D.
AG 9-13	72	180	52	140	N.D.	N.D.
MINERALIZED						
HAH 7-10B[2]	1300	51	50	93	Trace	Trace
AH 7-49[3]	150	30	50	N.D.	N.D.	N.D.

1. Unmineralized portion of metagabbro selected from specimen containing hairline fracture fillings of chalcopyrite and pyrite.
2. Platinum group metals looked for but not found.
3. Specimen containing sparse dissemenated fine-grained chalcopyrite.

N.D. = Not determined.

Analyses by Geoscience Laboratories, Ontario Geological Survey.

PA 311144, disseminated pyrite and pyrrhotite (4 to 6 percent) again occur along fracture planes in gabbro. On claim PA 311716, along the shore of an unnamed lake, minor chalcopyrite and malachite are found in quartz veins, within gabbroic rocks (D.A. Sawyer, Great Plains Development Company of Canada Limited, personal communication, 1972).

A detailed lithogeochemical and geological survey might delineate possible copper-nickel anomalous zones within the Horseshoe Lake gabbro pluton. Environments considered especially favourable for copper-nickel sulphide deposition involve geological contacts and shear zones as exemplified elsewhere in the map-area by copper-nickel showings at McVicar Lake in the Lang Lake belt and Woodilee Lake in the Pashkokogan Lake-Misehkow River belt.

PROPERTY DESCRIPTIONS

Great Plains Development Company of Canada Limited [1973]

From 1971 to 1973, Great Plains Development Company of Canada Limited was involved with a major exploration program in the Horseshoe Lake belt. A total of 455 claims virtually covered the belt. An airborne magnetic-

electromagnetic survey delineated numerous anomalies which were principally investigated by ground geophysics and diamond drilling in two areas:

(1) "Rose Lake" (local name) area, in the extreme northeastern area of the Horseshoe Lake belt, and,

(2) Horseshoe-Kecheokagan Lakes area.

In 1973 after a total of 1860 m of diamond drilling which intersected no significant mineralization (Assessment Files Research Office, Ontario Geological Survey, Toronto) Great Plains Development Company of Canada Limited decided to terminate their interest in the Horseshoe Lake belt.

Rio Tinto Sulphide Occurrences

Initial recorded mineral exploration in this belt was undertaken by Rio Tinto Canadian Exploration Limited in 1962, as part of the "Patricia Project" (Hall 1962, p.3). Three claim-groups totalling 19 claims were staked in order to more fully investigate several mineralized zones along the south shoreline area of Horseshoe Lake (Figure 5). These groups were respectively named the Sulphide Zone Group, Rust Seep Group, and Shear Zone Group (Hall 1962).

On the Sulphide Zone Group, a series of concordant massive sulphide horizons have been indicated by ground magnetic and electromagnetic surveys by both Rio Tinto Canadian Exploration Limited (Hall 1962, p.8-9) and Great Plains Development Company of Canada Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto). One diamond drill hole of Rio Tinto Canadian Exploration Limited intersected one massive sulphide horizon having a cumulative thickness of 7.6 m. Strike lengths of strong conductive horizons vary up to 300 m (Hall 1962, p.8). This sulphide zone occurs within schistose chloritic mafic metavolcanics associated with local intercalations of dacitic lapilli tuff (sample AH7-50, Appendix A, Chart C, back pocket). Best core assays by Rio Tinto Canadian Exploration Limited, indicated 0.12 percent copper over 0.30 m, 0.05 ounces gold per ton over 0.94 m, and 0.06 ounces silver per ton over 0.43 m (Assessment Files Research Office). On site of the diamond drill hole a pronounced reddish brown gossan development is apparent.

Ground electromagnetic coverage on the Rust Seep Group failed to delineate any important conductors. Three soil samples of Rio Tinto Canadian Exploration Limited, registered anomalous copper values (1700 ppm, 435 ppm, 300 ppm) and average zinc values (Hall 1962, p.10). No explanation as to the origin of significance of the high copper values was given by Rio Tinto Canadian Exploration Limited.

Sampling across a 2.9 m wide mineralized shear zone on the Shear Zone Group by Rio Tinto Canadian Exploration Limited registered best assays of 0.20 ounces of gold per ton and 0.18 ounces of silver per ton over 0.3 m (Hall 1962, p.11), although the method of sampling was not disclosed. In 1965, Rio Tinto Canadian Exploration Limited drilled four diamond drill holes totalling 365.0 m on claims PA 35424 and 35427 of this group (Diamond Drill Report 10, Assessment Files Research Office, Ontario Geological Survey, Toronto). These holes failed to intersect any promising mineralized zone at depth, and resulted in the cessation of the Patricia Project.

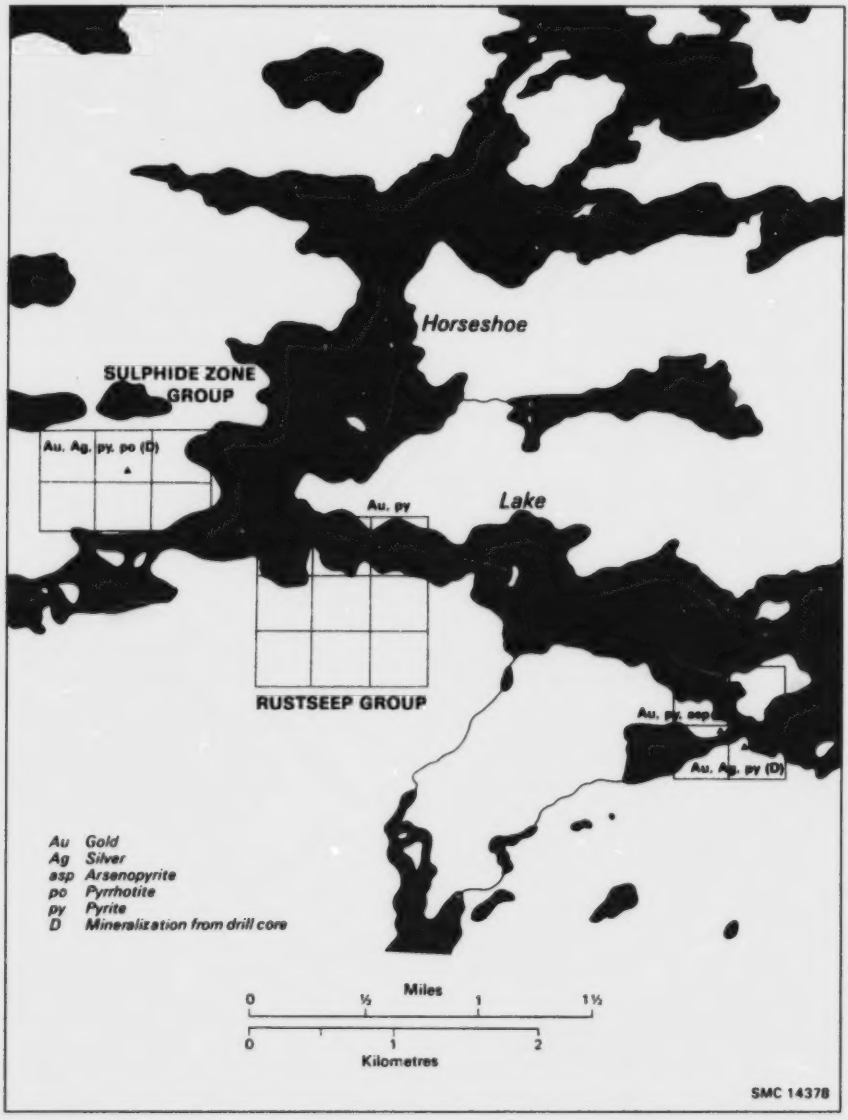


Figure 5–Location of claim groups and mineralized occurrences investigated by Rio Tinto Canadian Exploration Limited, southeast Horseshoe Lake area.

On the Shear Zone Group, disseminated pyrite (5 to 10 percent) is confined to a zone 1.2 m in width composed of a series of *en echelon* shears. The individual shears, which strike N20E are usually less than 5 mm in width. The host rock consists of massive, medium-grained gabbro. A grab sample taken by the field party of the mineralization registered 0.10 ounces of gold per ton, and traces of silver (assays by Geoscience Laboratories, Ontario Geological Survey). A qualitative spectrographic analysis indicated the presence of significant quantities of arsenic.

On claim PA 35425 on the southern shoreline of Horseshoe Lake a rusty pyritic shear zone trending N55E had been previously exposed by the stripping of Rio Tinto Canadian Exploration Limited.

Several of the sulphide occurrences situated on the aforementioned claim groups were examined during the present survey.

On the Shear Zone Group, mineralization appears largely confined to narrow quartz veinlets emplaced within shear zones as exemplified by the southeastern showing (see Figure 5). Pyrite, the only sulphide observed, is rather scarce (usually less than 5 percent) and apparently largely converted to a limonitic gossan. A few fractures normal to these veinlets contain sparse pyrite. A 1.5 m wide quartz-feldspar porphyry dike parallels this mineralized shear zone. A grab sample taken by the present survey from this occurrence recorded 0.08 ounces gold per ton and traces of silver (assays by Geoscience Laboratories, Ontario Geological Survey).

Along the northern margin of the Rust Seep claim group a gold occurrence previously indicated by Carruthers (1961) was briefly examined. The host rocks are schistose, chloritic, carbonatized fine-grained mafic metavolcanics. Deformed pillows are present, the elongation of which parallels the schistosity. The mineralization occurs in a rusty, intensely sheared zone which approximately parallels the shoreline of Horseshoe Lake. Small ovoid areas up to 60 cm in length consist largely of granular pyrite with ancillary fragments of chloritic material. Local impregnations of quartz are fractured and engulfed by pyrite. No other sulphide mineral was observed. Two grab samples of the pyritic material taken by the field party recorded trace to 0.02 ounces gold per ton, traces of silver (assay by Geoscience Laboratories), and no significant quantities of any other economically important metals as revealed by emission spectroscopy.

RECOMMENDATIONS FOR FUTURE EXPLORATION

Mineral exploration in the Horseshoe Lake belt to date has focused on the gold potential of pyritic shear zones and more recently upon volcanogenic massive sulphide possibilities.

The large Horseshoe Lake gabbro pluton warrants a more extensive geological and lithogeochemical study. This pluton may contain appreciable quantities of disseminated or fracture-controlled chalcopyrite-pyrrhotite-pyrite mineralization. This type of mineralization would either be missed or register as weak anomalies in airborne electromagnetic surveys. Pods of massive pyrrhotite have also been demonstrated to exist in the pluton by Great Plains De-

velopment Company of Canada Limited. Close attention should be paid to the possibility of mineralization being controlled by pluton contacts, shear systems, and contacts with supracrustal remnants engulfed within the pluton.

Felsic metavolcanics are notably scarce in the Horseshoe Lake belt, at least in the areas of rock exposure, thus the potential for occurrence of volcanogenic base-metal sulphide deposits does not appear to be high.

FORESTER LAKE BELT

The Forester Lake metavolcanic-metasedimentary belt represents a southeast extension of the Weagamow-North Caribou Lakes belt (Thurston *et al.* 1979). Within the map-area this belt extends 48 km in a southeasterly direction. Forester Lake is located 109 km north of Pickle Lake. The area can be reached by float plane from Pickle or Mawley Lakes. Outcrop is scarce, constituting less than 1 percent of the area, and is essentially limited to shoreline and near-shore areas of Forester, Sage (local name), Boyce and Neawagank Lakes.

Of the exposed metavolcanic-metasedimentary assemblage, mafic to intermediate metavolcanics are the predominant rock type (Figure 6, Chart A, back pocket). Metavolcanics of intermediate to felsic composition were not encountered. The metasediments are represented by a poorly exposed series along the northern boundary of the map-area. Thick flows, possibly gabbroic sills, are found along the south shore of Sage Lake. Ultramafic intrusive rocks, although only outcropping in one location, were intersected by drill holes of Rio Tinto Canadian Explorations Limited at several locations (Assessment Files Research Office, Ontario Geological Survey, Toronto). Felsic intrusions in the form of narrow quartz-feldspar porphyry dikes were encountered along Sage Lake.

Previous geological mapping of the area included Geological Survey of Canada Map 1-1962 by Emslie (1962) at a scale of 1 inch to 4 miles (1:253 440) and claim-line mapping by Rio Tinto Canadian Exploration Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto).

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics, the predominant rock type within this belt, consist of massive to foliated andesite to basalt, pillowed andesite to basalt, amphibolite, and mafic tuff to agglomerate. Pillowed mafic metavolcanics are restricted to the less deformed areas in the centre of the belt.

These rocks are characterized by dark green to black fresh surfaces and dark grey to green, typically pitted, weathered surfaces. The common metamorphic mineral assemblage consists of amphibole + andesine ± quartz ± epidote ± carbonate ± opaques. Pillows occur as small sausage-like forms dis-

playing a restricted size range with an estimated mean size of 8 by 30 cm. Pillows are generally amygdaloidal, with selvedges which weather a darker colour than the pillow centres and range in thickness from 1 to 2 cm.

Mafic tuff and agglomerate is present in several locations but is poorly exposed. Outcrops are small, often highly sheared and not traceable along strike due to extensive bush cover. Lapilli-tuff units have brown-green mottled fresh surfaces and weather grey-brown. Along the southern margin of the belt a contact-metamorphic aureole consisting of amphibolite *lit-par-lit* injection gneiss is especially notable.

METASEDIMENTS

A poorly exposed metasedimentary sequence extends along the northern boundary of the map-area. Exposure of this sequence within the map-area is limited to small outcrops along Neawagank Lake and a small unnamed river situated east of the lake. Distinguishable rock types are arkose, siltstone and greywacke, subsequently metamorphosed to biotite-quartz-feldspar schists and gneisses. The common metamorphic assemblages in order of decreasing mineral abundance include:

1) quartz + plagioclase + biotite ± muscovite ± cordierite ± andalusite ± carbonate;
2) plagioclase + quartz ± biotite ± muscovite ± garnet ± cordierite ± andalusite.

In the region to the north of the map-area this sequence is exposed along the shoreline of Markop Lake and the Pipestone River. Thurston *et al.* (1979) described lithic arkose interbedded with lenses of pebble and boulder conglomerate and minor greywacke. Thurston *et al.* (1979) interpreted the thick bedding, the absence of abundant mudstone beds in the greywackes, the lack of ripple marks, and the presence of occasional scour features and conglomeratic lenses as indicative of a proximal turbidite depositional facies. In the Forester Lake area the predominance of greywacke and argillite plus the absence of conglomerate lenses and lithic arkose may indicate that these rocks are a more distal facies equivalent of the Markop Lake-Pipestone River succession.

IRON FORMATION

Iron formation was not observed in the Forester Lake area during the present survey. Several strong linear magnetic anomalies aligned northeast and north-northwest attain maximum intensities of 73 000 gammas absolute total field between Sage and Neawagank Lakes (Map 937G, ODM-GSC 1960). These data coupled with strong local compass deviations encountered in this area suggest the presence of iron formation. Rio Tinto Canadian Exploration Limited mapped one outcrop of rusty iron formation near the western end of Sage Lake (Hall 1962, p.5). Iron formation is also indicated to occur 500 m and 730 m

due north from the extreme eastern end of Sage Lake by Robertson (1941). Mafic intrusive rocks were also reported north and east of Sage Lake by Robertson (1941).

ULTRAMAFIC INTRUSIVE ROCKS

Ultramafic rocks in the Forester Lake belt were observed only along the west-central shoreline of Forester Lake and on the former "West Forester Lake" claim group of Rio Tinto Canadian Exploration Limited (Boleantu 1961). Detailed mapping by Rio Tinto Canadian Exploration Limited during 1962 disclosed these rocks to generally occur as small, poorly exposed, lenticular to ovoid shaped pods, ranging between 15 and 75 m in width, and between 75 and 300 m in length (Boleantu 1961; Hall 1962). Although not observed in contact with enclosing mafic to intermediate metavolcanics the long dimension of these lenses parallels the host rock foliation. These rocks, predominantly peridotite, are massive, porphyritic and/or porphyroblastic, black on fresh surface and rusty brown on weathered surface. In thin section the following mineral assemblage in order of decreasing mineral abundance was observed: cummingtonite + serpentine + carbonate + olivine ± magnetite.

A significant ovoid aeromagnetic anomaly, exceeding 62 000 gammas total absolute field (Map 927G, ODM-GSC 1960), is situated over the western portion of Forester Lake. This anomaly could indicate significant volumes of magnetic ultramafic flows and/or sills intercalated with the predominant mafic metavolcanics, however, owing to paucity of outcrop the possibility of iron formation cannot be discounted.

QUARTZ AND QUARTZ-FELDSPAR PORPHYRY

Quartz and quartz-feldspar porphyry are exposed at several locations to the east of Forester Lake. These rocks contain 1 mm by 1 mm quartz and feldspar phenocrysts in a fine-grained aphanitic groundmass which consists of recrystallized quartz, albite, and biotite. Fresh surfaces vary from grey to a mottled white-grey and weathered surfaces are generally light grey or white.

Paucity of outcrop prohibits tracing these dikes along strike. Where exposed, however, they are concordant to the metamorphic foliation and vary in thickness from 1 to 8 m.

Structural Geology

The Forester Lake metavolcanic-metasedimentary belt has been metamorphosed to the almandine amphibolite facies, complexly folded, intruded and migmatized by the surrounding granitic batholiths. Shearing and metamorphism have destroyed most of the primary structures and have produced a nearly vertical east-west foliation defined by the subparallel orientation of am-

phibole and mica. The lack of distinctive marker horizons, top determinations and the paucity of outcrop prohibit detailed analysis of the nature of the folds. Thurston *et al.* (1979) interpreted the Weagamow-North Caribou Lakes belt, to the north, as a steeply dipping isoclinal syncline. Forceful diapiric intrusion of a granitic stock along the southern border of the belt has warped the metavolcanics into a northwest trend.

This belt differs from the Weagamow-North Caribou Lakes belt in that the metasediments are in contact with the granitic batholith to the north and are not flanked by metavolcanics on both sides. Whether this represents the original extent of the volcanic flows or engulfing of the volcanic unit by intrusion of the batholith could not be determined. The strong sinusoidal aeromagnetic trends interpreted as iron formation (Map 937G, ODM-GSC 1960) suggest the possibility of folding and/or faulting in the eastern extremity of the belt.

Economic Geology

Earliest record of mineral exploration within this belt dates back to 1941. At this time mineralized quartz vein grab samples reported to contain 5.14 and 5.33 ounces gold per ton instigated a staking rush involving a total 182 recorded claims by several mining companies and individuals (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). The initial discovery occurred near a small lake (locally named Wesley Lake) situated approximately 9 km east of Forester Lake, and later became part of the Jardine Syndicate claim group. On claim PA 5506 of the Hooker-Wilson claim group favourable gold values were also encountered within a mineralized quartz vein, situated about 450 m east-northeast from the eastern end of Sage Lake. Despite extensive prospecting, stripping and sampling of the numerous quartz veins, widespread within the Forester Lake belt, interest in gold soon abated. A detailed investigation of the major mineral occurrences and geological mapping (1 inch to 1,000 feet) of the area proximal to the major showing (claim PA 5506) on the Hooker-Wilson group was completed by Robertson (1941).

In the late 1950s and early 1960s, the Forester Lake belt was prospected by W. Taylor and M. Stewart, who held a claim group on the western end of Forester Lake.

From 1961 to 1965 Rio Tinto Canadian Exploration Limited carried out a major mineral exploration program. The first phase involved a fixed-wing supported geological reconnaissance mapping program approximately 12 000 km^2 in extent and covering the Forester Lake and Horseshoe Lake metavolcanic-metasedimentary belts. Follow-up prospecting, geological mapping, airborne and ground electromagnetic surveys and diamond drilling focused on several mineralized areas delineated by this survey. Discouraging results forced a cessation of this program in 1965. In 1962, The International Nickel Company of Canada Limited intersected disseminated to massive pyrrhotite, pyrite, arsenopyrite mineralization in a diamond drill hole situated on claim PA 28995, at Forester Lake, presumably detected by an airborne electromagnetic survey (Diamond Drill Report, Assessment Files Research Office, Ontario Geological Survey, Toronto). Little record of this company's past activity in the Forester Lake belt is available.

PROPERTY DESCRIPTIONS

Hooker-Wilson Gold Occurrence

In 1941, the Hooker-Wilson Syndicate controlled 52 claims in the Sage Lake area, about 4 km east of Forester Lake. Gold was initially discovered in a mineralized quartz vein within an east-trending shear zone following the contact of a large mafic metavolcanic raft within massive gabbro. A series of trenches exposed this vein for approximately 25 m. The shear zone is traceable for approximately 90 m, according to Robertson (1941, p.11) averaging

> ...15 feet in width, but to the east it narrows rapidly to average only three feet in width. The quartz found in the shear appears as a tear shaped body with its maximum width being over 28 feet at the original discovery, and pinching off westward until at 150 feet, only stringers of quartz were uncovered. Trenching to the east exposed only stringers of quartz in a comparatively narrow shear zone. The quartz contains little mineral. In the wall rock, and local inclusions of greenstone in the quartz, are found pyrite, arsenopyrite, chalcopyrite, and galena...

Robertson (1941, p.10) also reported disseminated sulphide mineralization in massive gabbro outcropping on the Hooker-Wilson claim group. Mineralization mainly consists of pyrite, accompanied by minor arsenopyrite.

Very low to nil values in 35 grab samples were reported by Robertson (1941, p.11). The highest value reported by Robertson contained 0.05 ounces gold per ton. Contrarily, assays by Pickle Crow Gold Mines Limited in 1941 on grab samples selected from a trench exposing 6 m of quartz vein revealed the following results (Robertson 1941):

Nature of sample	Ounces gold per ton
Barren quartz	0.02
Quartz with sulphides	0.46
Quartz with sulphides	0.30
Quartz with sulphides	0.56
Quartz with sulphides	0.62, 0.76
Massive sulphides	3.46, 3.06

It is interesting to note that there is no record of any diamond drill investigation of these values to depth.

Jardine Arsenopyrite Occurrence

Forty-five claims were staked in 1941 by the Jardine Syndicate immediately east of the Hooker-Wilson group. On the northwestern shore of Wesley Lake (local name), a shear zone traceable for about 300 m, striking N70E and steeply dipping to the south, is mineralized in places with massive arsenopyrite. A showing on Wesley Lake was reported to contain 0.54 ounces gold per ton (Robertson 1941, p.12). A grab sample of massive arsenopyrite mineralization collected by the present survey from Wesley Lake was found to contain 0.01 ounces gold per ton and a trace of silver. Emission spectroscopy failed to disclose any significant quantities of other important metals.

Three claim groups within the Forester Lake belt and respectively located at the western end of Forester Lake (12 claims), Sage Lake (5 claims), and 1.6 km southeast of Sage Lake (4 claims) were investigated in detail in 1961 by Rio Tinto Canadian Explorations Limited. Detailed geological mapping (1 inch to 200 feet and 400 feet) and ground electromagnetic surveys were conducted on the first two claim groups while only a cursory geological and sampling investigation was made on the latter group.

A major part of Rio Tinto's activity centred around the Forester Lake claim group. Previous development by W. Taylor and M. Stewart involved trenching of a 3 to 12 m wide mineralized, silicified shear zone (since located on Rio Tinto claim PA 29924) in mafic metavolcanics and metasediments near the southern contact of the Forester Lake belt. Description of this mineralization was given by Boleantu (1961):

> The 3 trenches cut across a wide silicified, mineralized volcanic zone. Also present are quartz veins ranging in thickness from ½ to 1½''. The larger veins are commonly saccharoidal and leached. The smaller quartz veins and shears still retain pyrite mineralization. Along the south end of each trench occur two 2-3'' pegmatite bands, and in No.1 trench aplite dikes. An apparent 2' shear zone of chloritic schist occurs through each trench. This probably represents an altered serpentinite associated with the peridotite intrusions. The presence of mariposite (nickel-mica) in the quartz veining close to the pegmatite dikes indicates a probable enrichment of the pegmatites from the ultrabasic sills in the vicinity. Pyrite is probably associated with pegmatitic activity. In the No.1 trench metasediments occur along the northern margin. It can be assumed that silicification and mineralization occurred along the volcanic sedimentary boundary which was fractured during one period of shearing stress. No minerals of economic importance were assayed from the trenches. Minor molybdenite occurs in the pegmatites cutting the trenches.

Minor pyrrhotite and chalcopyrite also occur within the gossan-mantled shears. One assay by Rio Tinto Canadian Exploration Limited returned 0.04 percent copper, 0.07 ounces silver per ton, trace gold, and nil MoS_2 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Several narrow (15 to 60 m width) dark greenish black (fresh surface) ultramafic sills were mapped by Rio Tinto Canadian Exploration Limited and by the present survey.

These rocks invariably contain magnetite and attract a suspended hand magnet to varying degrees. Boleantu (1961, p.4) reported magnetic susceptibilities sufficiently high to affect certain compass traverses. Three Rio Tinto samples respectively assayed 0.07, 0.16, and 0.18 percent nickel and nil to 0.01 percent cobalt (Boleantu 1961, p.8).

The extent of these ultramafic sills could not be evaluated by the Rio Tinto Canadian Exploration Limited survey, as many of these intrusions are probably covered by muskeg and Forester Lake. A ground magnetic survey would be of obvious aid in exploring these units for potential disseminated copper-nickel mineralization.

Although 14 conductive zones were detected by an airborne electromagnetic survey (Hall 1962, p.6), only two short diamond drill holes were drilled (45 m total) on a major electromagnetic conductor on claim PA 29927. Massive pyrrhotite mineralization (40-60 percent sulphide up to 1.9 m in thickness), ac-

companied by graphite was intersected within agglomeratic rocks of unspecified composition (Boleantu 1961). Assays of the mineralized material by Rio Tinto Canadian Exploration Limited disclosed nil to 0.02 ounces gold per ton, nil to 0.05 percent copper, and nil nickel.

RECOMMENDATIONS FOR FUTURE EXPLORATION

The ultramafic sills and/or flows at the west end of Forester Lake merit a closer investigation with respect to their distribution and economic potential. Ground magnetic surveys would greatly facilitate evaluating the extent of these appreciably magnetic rocks. A high resolution airborne magnetic survey over the Forester Lake belt would greatly facilitate detailed mapping and unravelling the gross stratigraphy. The high gold values attained by Central Patricia Gold Mines Limited on the Hooker-Jardine claim group (in Robertson 1941) are especially worthy of a follow-up survey.

PINEIMUTA RIVER BELT

The Pineimuta River belt is notable for its paucity of outcrop. One dark coloured outcrop on the Totogan River was spotted from the air, but was inaccessable to the helicopter. A southeast trending aeromagnetic anomaly on maps 937G and 947G (ODM-GSC 1960) suggests the presence of a belt approximately 30 km in length with a maximum width 6 km. This belt extends from the northeastern end of Neawagank Lake to the Totogan Creek area. From its relatively narrow width and general similarity in magnetic pattern with those areas known to consist of metavolcanics intruded by granitic rocks, the belt is thought to consist largely of amphibolites intruded with granitic rocks.

Near the centre of the belt near the junction of the Dumond and Pineimuta Rivers, a linear magnetic anomaly locally exceeding 68,000 gammas (Map 947G, ODM-GSC 1960) is interpreted to indicate an iron formation.

Duffell *et al.* (1963) have previously suggested the presence of this belt from aeromagnetic data.

Economic Geology

There is no record of any mineral exploration within this belt primarily owing to the very scant outcrop. It is possible that an interpreted iron formation situated at the confluence of the Dumond and Pineimuta Rivers (8 km in length and locally exceeding 68 000 gammas total field intensity) has attracted some exploration attention (Map 947G, ODM-GSC 1960).

WIGWASCENCE LAKE BELT

Investigation of the rocks at the north end of Wigwascence Lake revealed a weak correlation between the geology and the linear magnetic anomaly on aeromagnetic map 947G (ODM-GSC 1960). In general, the rocks are foliated to gneissic biotite and amphibole trondhjemite. Linear bands of amphibolite were found at several outcrops on the north shore of the lake. These are thought to represent the remobilized, deeply eroded section of a former metavolcanic belt.

Economic Geology

No known prospecting or mineral exploration has been recorded in this belt. It is possible that the Patricia Project of Rio Tinto Canadian Exploration Limited examined exposures along Wigwascence Lake. No sulphide mineral occurrences were encountered by the present survey.

Metavolcanic-Metasedimentary Belts of the Uchi Lake Subprovince

JACKPINE LAKE BELT

The Jackpine Lake belt is located at the western edge of the map-area, approximately 120 km west of Pickle Lake. The belt, about 4 km in diameter, consists of an arcuate band of amphibolite, locally highly folded and surrounded on both sides by a fine to medium grained, sacchroidal, gneissic felsic rock, which is tenuously classified as igneous and intrusive. A thin felsic to intermediate volcanic unit occurs within the larger amphibolite band. These lithologic units have all been intruded by later granitic pegmatite and aplite, and are metamorphosed to the middle amphibolite facies. Outcrops within the area are not abundant; outcrop density is 1 to 2 percent.

Initial geologic interest was drawn to the Jackpine Lake area by a prominent circular aeromagnetic pattern which is well displayed by Map 893G (ODM-GSC 1960). L.D. Ayres, formerly of the Ontario Division of Mines, who earlier had completed a reconnaissance mapping program in the general region, pointed out to members of the field party at the start of the field season the unusual nature of some of the granitic rocks of the Jackpine Lake area.

Prominent arcuate linear features visible on air photos of Jackpine Lake are controlled to a large degree by the bedrock geology. The possibility that these features were of meteorite origin was considered, however, no shatter cones or evidence of shock metamorphism was found in the area.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

A prominent feature of the Jackpine Lake area is the arcuate band of amphibolite which is thought to represent a mafic to intermediate volcanic unit. Primary structures are absent and the rock is now a fine to medium grained, dark green to black, schistose to gneissic amphibolite. Its position can be roughly traced by lake patterns on air photos of the area and magnetic contours on Map 893G (ODM-GSC 1960). Visual estimates of the mode are hornblende 30-35 percent, epidote 10-20 percent, plagioclase (calcic andesine) 40-50 percent, and magnetite 2 percent. A trace of actinolite was noted. The minerals were equigranular and concentrated into bands.

A thin section of a xenolithic block of metamorphosed mafic to intermediate metavolcanics from the northwest end of Jackpine Lake contained nearly 20 percent augite.

FELSIC TO INTERMEDIATE METAVOLCANICS

Within the arcuate unit of amphibolite, a thin band of felsic to intermediate metavolcanics is present which is conformable with the amphibolites. Primary volcanic textures are absent in this unit. The rock is grey-orange on the weathered surface, fine to medium grained, equigranular, and has a well developed gneissic banding. On fresh surface the rock is pink to light pink in colour. The unit often contains abundant intrusions of granitic pegmatite.

The possibility must be considered that this interpreted felsic to intermediate metavolcanic unit is related to the granitic rocks found on both sides of the amphibolite band, but this awaits additional petrographic and field work.

IRON FORMATION

Along the west side of a small bay on the west side of the channel leading into the small lake southwest of Jackpine Lake a thin unit of magnetic iron formation was observed.

East of Jackpine Lake, on the west side and south of the center of a small arcuate lake, samples of magnetite-pyrite iron formation were found but their source could not be located.

FELSIC INTRUSIVE ROCKS

The rocks of the Jackpine Lake area have been intruded abundantly with aplite and coarse grained granitic dikes which are thought to be related to the surrounding granitic batholiths. These late granitic rocks are massive.

Structural Geology

The arcuate nature of the metavolcanics is well displayed in the outward dipping foliations measured on the exposed outcrops, fracture patterns and topographic features. Mismatching of lithologic units across the channel leading from Jackpine Lake to Kapikik Lake suggests faulting along this channelway. For similar reasons a fault is thought to exist in the channelway in the southwest corner of Jackpine Lake which leads in to a small lake that flanks Jackpine Lake to the southwest.

The axes of abundant drag folds in the Jackpine Lake area plunge radially away from the center of the lake. It is suggested that the arcuate belt of metamorphosed mafic volcanic rocks represents a sheet, a partial cone in shape, that plunges outward away from the lake. Intuitive reasoning, but without field evidence, also suggests the unit could represent a ring dike. If these amphibolites are considered to be volcanic flows, then their present arcuate pattern and inferred cone-shape is probably due to the intrusion at the felsic stock centred in Jackpine Lake.

Economic Geology

No occurrences containing economically important minerals were found associated with the Jackpine Lake belt.

ZIONZ LAKE BELT

The Zionz Lake belt is located at the western edge of the map-area, about 5 km south of the Jackpine Lake belt, and 120 km west of Pickle Lake. The metavolcanics and metasediments are considered to be a lobe of the Birch Lake-Uchi Lake belt to the west. The rocks consist of predominantly mafic to intermediate metavolcanics which have been metamorphosed to upper greenschist and middle amphibolite facies of regional metamorphism. Minor felsic to intermediate metavolcanics occur along the south margin of the belt and two thin iron formation units occur on the north shore in association with metasediments of predominantly greywacke composition. A thick unit of metasediments along the northern margin of Zionz Lake consists predominantly of greywacke with minor thin beds of arkose.

In the northwest arm of Zionz Lake fine-grained saccharoidal felsic rocks occur which appear to be similar to rocks found in the Jackpine Lake area which are tentatively classified as metamorphosed, intrusive, granodiorite. Phases of later granitic intrusions cut this unit and have incorporated xenolithic fragments of the granodiorite. A late granitic intrusion is centered over Zionz Lake and will be referred to as the Zionz Lake Stock.

The general outline of the Zionz Lake metasedimentary-metavolcanic belt can be seen on aeromagnetic map 893G (ODM-GSC 1960). Aeromagnetic maps and scattered outcrop data suggest that the Zionz Lake metavolcanics and met-

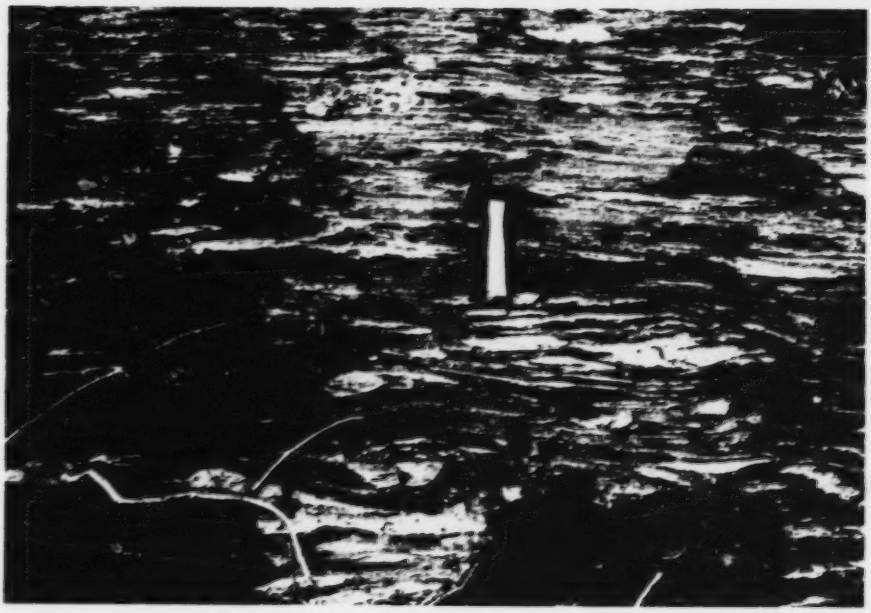


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Photo 4–Deformed volcanic breccia, south shore of Zionz Lake on channel into Fawcett Lake, Zionz Lake belt.

asediments may have formerly been connected to the Meen-Dempster Lakes metasedimentary-metavolcanic belt. A migmatized septum of amphibolite broken by areas of granitic rock containing numerous isolated xenolithic blocks of amphibolite is interpreted to exist between Zionz Lake and Meen Lake. This zone, estimated to be less than 1.6 km in width, passes just south of Gitchie Lake and its location and width are based on airborne, aeromagnetic map interpretation, and scattered outcrop visits.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The mafic to intermediate metavolcanics are presently represented by medium to coarse grained amphibolite and chlorite schists. The rocks display a well developed foliation, are equigranular and dark greenish black on fresh surface. The weathered surface is of a lighter hue than the fresh surface. Rare occurrences of highly deformed pillow structures are present and thin zones of recognizable tuffs and breccias were recorded (Photo 4). Some thick, more

massive amphibolites are probable sill-like intrusions and others probably represent thick flow centers. The metamorphic grade appears to range from middle greenschist to middle amphibolite facies.

Along the west side of a small bay in the southwest corner of Zionz Lake, a pronounced rodding of fragments is present in a metamorphosed mafic agglomerate. Rodding and minor folding in the area plunge east parallel to the foliation. An outcrop of mafic metavolcanics in the same area has a sponge-like weathered surface possibly caused by the selective weathering out of sulphide minerals. A nearby quartz-feldspar porphyry dike displays a rodding of the quartz phenocrysts. The metamorphosed mafic volcanic rocks generally lack evidence of primary structures.

Locally the mafic metavolcanics contain small red garnets, especially on the schistosity planes associated with possible movement, e.g., slickenside. Marginally to the Zionz Lake belt and the Zionz Lake granitic stock, the mafic to intermediate metavolcanics are highly intruded with granitic aplite, pegmatite, and porphyry dikes.

FELSIC TO INTERMEDIATE METAVOLCANICS

Along the southern margin of the Zionz Lake metavolcanic-metasedimentary belt lies a thin unit of felsic to intermediate metavolcanics (too small to show on map). This unit is from 15 to 60 m wide and is concordant with the enclosing mafic metavolcanics. The unit pinches out to the northeast and to the southwest.

On weathered outcrop the rock is light grey to buff and displays a pronounced banding, and in places the individual bands are 4-5 mm wide. On fresh surface the rock is a dark grey, very fine-grained to aphanitic rock with traces of disseminated pyrite. The rock breaks with a poorly developed subconchoidal fracture. The rock is foliated and in places is visibly folded.

In thin section the very fine grained felsic to intermediate volcanic rock is visually estimated to contain 40-50 percent biotite, trace magnetite, and a mosaic of 50-60 percent quartz and plagioclase. The rock is considered by the writer to be of intermediate (andesite to dacite) composition, and may be either tuffaceous or sedimentary.

METASEDIMENTS

Along the northern side of Zionz Lake, an area of predominantly medium grained metasediments was recognized in the present mapping and former mapping by Emslie (1960). Minor amounts of amphibolite, likely of mafic volcanic or granitic intrusive origin, occur associated with biotite-quartz-plagioclase schists thought to be derived from sedimentary rocks of greywacke composition. Minor beds of predominantly quartz-feldspar rocks are dark-grey or grey-black on weathered surface, and grey, light grey and pink on fresh surfaces. The rocks are generally equigranular and medium grained (1-2 mm).

Visual estimates suggest a range in composition of 25-40 percent biotite, 15-60 percent quartz, 10-50 percent plagioclase, and locally significant amounts of hornblende are present. Some of the more hornblende-rich layers may be representative of former tuffaceous sediments. Several thin beds of relatively clean quartzite were also noted in the metasedimentary sequence. In thin-section the texture of the metasediments is granoblastic. The plagioclase is andesine and occasional grains are very weakly zoned. The hornblende is pleochroic light brown to green.

On the south margin of the belt a thin unit of conglomerate (not shown on map) was found which contains pebbles of feldspar porphyry, felsic volcanic rocks, and mafic volcanic rocks. The pebbles are elongated, 7.5 to 15 cm long and 5 to 7.5 cm wide. The pebble matrix is composed of hornblende, feldspar, quartz and chlorite. The composition of the pebbles and matrix indicates a volcanic source area.

On the north side of Zionz Lake and on the west side of the channel to Kapikik Lake a repeated sequence of quartz-amphibole schist, conglomerate, and fine grained quartz-biotite schist was noted. The composition of the cobbles, matrix, and associated metasediments is also suggestive of a volcanic source area.

IRON FORMATION

Two thin iron formation units were located in outcrop in the Zionz Lake belt. A 3 m unit of magnetite-bearing iron formation with minor pyrite, in association with quartz-amphibole schist possibly of metasedimentary origin and amphibolites possibly of volcanic origin, occurs near the entrance of the river leading to Cat Lake. The sedimentary layers average 0.45 to 0.6 m in width. A second occurrence of iron formation is located on the north shore of Zionz Lake in association with metasediments of greywacke composition. This unit is 6 m wide and consists of banded magnetite and quartz with minor hornblende. The lack of any significant aeromagnetic patterns in these areas suggests that the units are of only local extent (Map 893G, ODM-GSC 1960).

Structural Geology

Throughout the metavolcanic-metasedimentary belt minor folds plunging steeply to the east were noted, and rodding of fragments in pyroclastic rocks and pebbles in conglomerates is common. A synclinal structure is proposed for the belt. This interpretation is based on questionable top determinations, on pillowed metavolcanics, foliations and drag folds.

Along both the margins of the belt and contacts with the granite stock to the east, migmatization of the volcanic rocks is a common feature. Granitic veins cutting the metavolcanics display boudinage structures and ptygmatic style of intrusion. Porphyritic phases of the granite intruding the metamorphosed volcanic rocks and sedimentary rocks as dikes and sills contain feldspar crystals oriented parallel to the contact.

Along the channel leading north from Zionz Lake to Cat Lake, lithologic units do not line up across the channel, suggesting faulting of an unknown displacement.

Economic Geology

Very little mineral exploration has been recorded in this belt to date. Fort Reliance Minerals Limited investigated a very low-grade copper-nickel occurrence on Zionz Lake near the mouth of Zionz Creek, through geological mapping, trenching, and sampling during 1969. No important mineralization was encountered by the present survey.

FAWTHROP-SENIOR LAKES BELT

The Fawthrop-Senior Lakes belt (Figure 7, Chart A, back pocket), an eastern extension of the Birch-Uchi Lakes belt, is approximately 16 km long, extending from the west boundary (92° Longitude) of the map-area eastward to Senior Lake. The width of this linear belt increases from 1.1 km near the west boundary to a maximum of 3.9 km just west of Senior Lake. Access to this "greenstone" belt segment is by float-equipped plane to several large lakes within and adjacent to the belt.

Prior to the present mapping project the Geological Survey of Canada conducted a regional mapping survey which included the Fawthrop-Senior Lakes belt segment (Emslie 1960).

The outcrop density represents at least 30 percent of the surface area. The belt appears to contain a rather limited array of lithologic units. The lithology is dominated by mafic to intermediate metavolcanics while metasediments and felsic to intermediate metavolcanics are only very locally encountered. Mafic intrusions including altered ultramafic material prevail in the vicinity of an unnamed lake midway between Senior Lake and Fawthrop Lake. Dikes of quartz and/or feldspar porphyry parallel the general east-west foliation and are particularly prevalent in the east half of the belt. The overall structure of the belt is synclinal, plunging westward. This structural interpretation was inferred from air photographs of the area and from foliations in the various lithologic units.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The western half of the belt comprises foliated to massive and generally aphanitic to fine-grained mafic metavolcanics. No primary structures such as pillows or clasts were noted and stratigraphic top determinations were not pos-

sible from the observed outcrops.

The metavolcanics consist dominantly of hornblende and plagioclase, and chlorite is associated with local shearing. Toward the margins of the belt there is a change within the metavolcanics towards an increase in grain size with slight layering and mineral segregation. This is attributed to metamorphic contact effects related to the granitic batholiths to the north and south of the belt.

East of the midway point between the western boundary of the map-area and Senior lake, the stratigraphy displays a monotonous sequence of massive to foliated mafic metavolcanics. However, pillowed metavolcanics occur within an estimated 4 to 5 horizons within the central 1.6 km width of the eastern half of this belt. In almost all cases, top orientations could not be reliably determined, because shearing and folding have caused considerable distortion of the pillow structures. The pillows, although often distorted, are in some cases bun or loaf shaped with sizes averaging 45 by 10 cm.

FELSIC TO INTERMEDIATE METAVOLCANICS

Observed felsic to intermediate metavolcanics are restricted to two occurrences, one within 3.2 km of the west boundary of the map-area and the second at the east side of a small lake 1.6 km west of Senior Lake. The western occurrences consist of several rather narrow bands ranging from between 0.3 and 0.9 m up to greater than 9 m in width. These felsic units consist of aphanitic to very fine-grained massive units and lapilli-tuff.

The eastern occurrence consists of lapilli-tuff, and tuff with fragments up to 8 cm in size. The fragments are elongated, striking east and plunging 50°W. The felsic metavolcanics on this small lake are predominantly a fine-grained sericite schist and were not examined in thin section.

METASEDIMENTS

Metasediments were observed in only two outcrops in this belt and appear to form a volumetrically insignificant part of the stratigraphy. One of the outcrops is siltstone and is located 3.3 km northeast of Ferdinand Lake. The other more prominent outcrop is on the south edge almost 3.2 km east of the west boundary of the map-area. This particular outcrop contains interbeds of arkose and feldspathic greywacke. A visual estimate of the mode for the arkose shows quartz 70 percent, plagioclase (andesine) 15-20 percent, biotite 10 percent, muscovite 2 percent. The grains are fine sand size, generally equigranular and the bed is of undetermined width. An interlayer of poorly sorted feldspathic greywacke approximately 45 cm in width is biotite-rich with medium grained quartz and plagioclase and minor fine to medium grained garnet. Coarse sand size grains of quartz are scattered along some horizons within this interlayer.

Grain gradation within the metasediments was not recognized. The quartz-rich material was possibly derived from either a felsic volcanic source area within the belt, of which there seems to be a scarcity, or from a granitic area

marginal to the belt. There is uncertainty as to the provenance of the greywacke interbed but it may be volcanoclastic or of mixed origin.

The cause of the magnetic anomaly in the northeast part of the belt as noted on aeromagnetic map 892G (ODM-GSC 1960) could not be established in the field but is presumed to reflect an iron formation unit.

MAFIC AND ULTRAMAFIC INTRUSIVE ROCKS

Three areas of mafic intrusive rock were noted in the vicinity of an unnamed lake midway between Fawthrop and Senior Lakes but the extent of these bodies is unknown and all of them may be related. The composition of the mafic bodies is gabbro to diorite and the outcrops are everywhere observed to be typically massive and homogeneous with medium to coarse grained stubby subhedral hornblende in a finer grained plagioclase matrix. The largest continuous thickness of mafic intrusive rock occurs across the trend of the regional east-west foliation and is 0.3 to 0.5 km in width.

Generally, contacts of the mafic intrusion with the surrounding metavolcanics were not observed but mafic intrusive dikes, possibly related to the larger mafic intrusion, up to 15 m in width were found nearby. These dikes occur within the metavolcanics and trend parallel to the regional foliation.

Associated with the mafic intrusions and located in the eastern part of the same unnamed lake are two separate outcrop areas of highly altered ultramafic material. These are respectively very light green-grey and rusty brown weathering. On fresh surfaces each is dark greenish grey, and has a slightly felted or silky appearance. Sporadic pitting characterizes the weathered surfaces.

One of the ultramafic outcrops contains a mineral assemblage with a visually estimated mode as follows: chlorite 35 percent, tremolite 25 percent, hornblende 15 percent, carbonate 15 percent, and altered olivine 10 percent. The olivine has associated serpentine and magnetite along the polygonal fractures within the individual olivine grains. The matrix is composed of chlorite and tremolite clusters. The hornblende laths are subhedral and dispersed throughout the rock.

The second outcrop is more extensively altered with a similar mineralogy as above. However, the olivine is completely altered to rounded pseudomorphs in the form of serpentine surrounded by serpentine containing very fine magnetite which accentuates the shape of the former olivine grain. A more extensive foliation has been developed in this sample which is characterized by the alignment of the platy minerals.

Shear zones observed in one rusty weathered outcrop were deeply rust brown stained and frequently contained long whitish clusters of tremolite crystals.

FELDSPAR AND QUARTZ-FELDSPAR PORPHYRY

A distinctive feature of this belt is the abundance of quartz and feldspar porphyry dikes. Apart from one observed dike cutting across the general east-

west foliations, all other dikes characteristically trend parallel to the foliations and bear a similarly oriented foliation within themselves. They are seen throughout the width of the belt, and throughout the length to the west boundary. However, their frequency is markedly higher in the eastern half of the belt. These dikes are probably related to the epizonal Bamaji Lake complex.

The felsic dikes are most commonly porphyritic with plagioclase phenocrysts, but occasionally some quartz-plagioclase porphyry dikes are present. The phenocrysts are usually less than 2 mm in diameter and make up a variable proportion of the dikes, generally between 10-30 percent of the rock. The plagioclase phenocrysts are subhedral to anhedral and the quartz phenocrysts are generally subrounded. Quartz phenocrysts may be singular or composed of composite grains which are often internally suture-bordered. The plagioclase varies from An_{28} to An_{38}, i.e., oligoclase-andesine. The distribution of the phenocrysts within most dikes is fairly uniform but in at least two dikes the phenocrysts appear to be concentrated close to the contacts with the surrounding metavolcanics. There are several exposures where the phenocrysts are themselves fine grained but are enclosed in an aphanitic matrix.

The matrix is usually composed of very fine-grained polygonized quartz and plagioclase with biotite. The biotite flakes are commonly oriented accentuating the weak foliation trend of the enclosing rock. Biotite normally occurs within the matrix but one example was found where this mineral also comprised 5 percent of the phenocrysts.

Widths of the dikes are variable, ranging from 10 cm to 6 m but generally averaging 30 cm to 1.2 m. Contacts with the surrounding metavolcanics and mafic intrusions are notably sharp with little or no contact effects apparent. Only minor fracturing of the enclosing rocks occurs and fragments of the wall rock occurring within the dike display only very local displacement.

METAMORPHISM

The grade of metamorphism appears to be of lower amphibolite facies rank of regional metamorphism. The plagioclase composition, where noted, is consistently oligoclase-andesine with an An content greater than 15 percent. The occurrence of muscovite in the presence of quartz indicates that the grade did not reach the level of upper amphibolite facies.

Structural Geology

Airphoto interpretation plus measurements of the foliations and bedding, suggest that the Fawthrop-Senior Lakes belt is a synform plunging westward with a shallow plunge of approximately 30 degrees; the plunge was estimated at the hinge of the fold on Senior Lake. Only one reliable pillow top determination was obtained, thus the synformal interpretation is based on low reliability airphoto interpretation and foliation planes within the metavolcanics.

Bedding observed in the western part of the belt parallels the foliation. Towards the hinge of the fold in the east, bedding and banding, where observed,

swing around with the nose of the fold so that in places they are oriented almost north-south with dips of 50 degrees to the west. Nevertheless, foliation continues to trend approximately east-west, which seems to indicate that at least the predominant foliation developed in this belt is an axial plane foliation.

The east plunging synform (Figure 8, Chart A, back pocket) in the vicinity of Wesleyan Lake is an eastern complement to the eastern extension of the Birch-Uchi Lakes synform. They are oppositely plunging structures, bearing the same monotonous lithology of mafic to intermediate metavolcanics. They are on strike with each other and separated by a distance across a portion of the Bamaji Lake complex of approximately 5.1 km. It is reasonable to suggest that these two synforms were once connected having later flexed in opposite directions perhaps partly as a result of the domal rising of the epizonal intrusion of the Bamaji Lake complex. Subsequent erosion has been sufficient to separate the belt into two presently observed synforms. Within these two synforms we may be presently observing an oblique cross section of a once-connected belt. The lithology of these belts is almost exclusively composed of mafic to intermediate metavolcanics along with mafic and ultramafic intrusive rocks and very minor units of felsic to intermediate metavolcanics and metasediments, suggesting the present belts are lower stratigraphic sections of a volcanic pile.

Economic Geology

Recorded mineral exploration within this belt has been minimal to date. The only major activity was centered around the Fawthrop Lake molybdenite option of Madsen Red Lake Gold Mines Limited in 1969.

PROPERTY DESCRIPTIONS

Fawthrop Lake Molybdenum Occurrence

The Fawthrop Lake molybdenite deposit is situated marginal to the Birch Lake-Uchi Lake belt extension, approximately 2.5 km southeast of Fawthrop Lake. Immediate access is best gained via helicopter, as there is a lack of suitable lakes for float-equipped fixed-wing aircraft. Innes (1970) reported that access to the No. 1 showing can be gained by aircraft on a small unnamed east-west trending lake, if only very light loads are taken. Hailstone Lake, situated approximately 4 km southwest of this lake, is probably the safest lake for bush-craft landings.

Investigation of the mineralization was carried out by Madsen Red Lake Gold Mines Limited during 1969 (Innes 1969). The property, originally staked by Daniel Panacheese of Madsen, comprised 20 claims (KRL 71625 to 71644 inclusive), with Madsen Red Lake Gold Mines Limited later adding 28 claims (KRL 201596-201619 and 223411 to 223414, both groups inclusive). Develop-

ment work focused on two showings approximately 0.8 km apart, located on claims KRL 71634 (No. 1 showing) and KRL 71642 (No. 2 showing). This consisted of extensive trenching, sampling, and four short diamond drill holes totalling 114 m. Although favourable values were registered during the trenching (best assay 1.15 percent MoS_2 over 2.1 m) subsequent diamond drilling proved generally discouraging (diamond drilling reports 10 and 11, Assessment Files Research Office, Ontario Geological Survey, Toronto) and the option was discontinued in 1970.

Only the No. 1 showing (original showing) was examined by the present survey.

Geology Both mineralized showings are apparently localized along the contact of the Birch Lake-Uchi Lake metavolcanic belt and granitic rocks situated to the north. At the No. 1 showing the molybdenite occurs in two distinct situations:

(1) within a series of relatively narrow pinch and swell concordant granitic dikes abruptly intrusive into foliated to gneissic, amphibolitized mafic metavolcanics; and,

(2) within massive to foliated trondhjemitic rocks immediately north of the metavolcanic contact.

The granitic dikes, which vary in width from 1 to 5 m consist of coarse to very coarse grained, massive to foliated, leucocratic biotite granodiorite to quartz monzonite. These dikes generally appear pegmatitic and often are porphyritic characterized by large phenocrysts of potassic feldspar (maximum length 30 cm) embedded within a comparatively finer-grained light grey (fresh surface) matrix. Coarse biotitic books, medium-grained yellow-green muscovite, and scattered fine-grained to medium-grained narrow trains of garnets are locally apparent within the granitic dikes. Xenoliths rich in hornblende and biotite occur as narrow discontinuous schlieren trending subparallel to the metavolcanic foliation. Foliations within the dikes are locally distinguishable by quartz lenses, muscovite orientation, and garnet trains.

Immediately north of the metavolcanic contact on the shore of the shore of the small unnamed east-west trending lake trenching and pitting was undertaken in light grey (fresh surface), massive to foliated, medium-grained, leucocratic trondhjemite, specifically focusing on a mineralized biotite-rich zone (15-20 percent) about 3 m in width. A very coarse-grained quartz vein consistently 45 cm in width occurs concordant to foliation in the midst of this biotitic zone. Late criss-crossing veins of pegmatitic quartz monzonite are prominent at the eastern exposed end of the mineralized zone.

Mineralization Within the granitic dike very coarse-grained molybdenite clots up to 1 cm in diameter and clusters up to about 2.5 cm in diameter occur in a disseminated fashion. There appears to be a frequent association of molybdenite clusters with yellow-green muscovite segregations. Otherwise, the molybdenite is sporadically scattered as sparse clots throughout the dike width. Overall, the mineralization accounts for less than 1 percent of the rock.

Spectacular molybdenite mineralization is present as a narrow zone (1 cm width) along the contact of a quartz vein with the biotite-enriched unit as exposed in the series of trenches north of the metavolcanic contact. Here, hexagonal single crystals which usually range between 5 to 10 mm in diameter and average about 8 mm, often concentrate into clusters. Plates of molybdenite usually occur parallel or slightly athwart the foliation surface of the trondhjemite. Molybdenite is estimated to constitute up to 20-30 percent of the rock in this instance. A grab sample taken by the writer of this mineralization registered 0.36 percent molybdenum (assay by Geoscience Laboratories, Ontario Geological Survey), and traces of gold and silver. An emission spectrographic analysis failed to disclose the presence of any other metal of economic interest, other than high lithium (0.05 to 0.5 percent).

Otherwise, molybdenite only occurs as odd clots in both massive trondhjemite and narrow quartz veins associated with the biotitic zone. Minor fine to medium grained pyrite, and fine-grained dark red-black fluorite accompanies the molybdenite in minor localized quantities.

Innes (1970, p.2) reported that the mineralization area as a whole was traced for a length of 60 m and a width varying from 9 to 12 m. The No. 2 showing has been described by Innes (1969, p.2) as follows:

> ...Molybdenite flakes were found in an area roughly 200 feet by 100 feet, associated with highly crenulated and/or rolling quartz vein with an overall flat dip of from 10 degrees to 45 degrees and varying in width from ½ inch to 6 inches, and also associated with narrow, ½ to 4 inches, steep south dipping quartz veins with an approximate east-west strike. The molybdenite flakes were present in both the quartz and in the adjacent granite gneiss.
>
> The steep quartz veins were developed only below the flat quartz veins and the molybdenite was present only to a vertical depth of about 6 feet below the flat quartz. Pyrite, pyrrhotite with minor chalcopyrite also associated with the steep quartz veins appeared to be increasing at this depth below the flat quartz.
>
> In spite of its widespread occurrence in the No.2 showing, molybdenite in concentrations of interest was found only in Trench No.12.

Best values obtained in three of four diamond drill holes drilled normal to structural trend of the molybdenite mineralized zones is as follows (diamond drill reports 10 and 11, Assessment Files Research Office, Ontario Geological Survey, Toronto):

Hole No. 1	0.08 percent MoS_2 over 1.38 m
Hole No. 2	0.96 percent MoS_2 over 0.64 m
Hole No. 3	0.08 percent MoS_2 over 0.58 m
Hole No. 4	No values obtained.

RECOMMENDATIONS FOR FUTURE EXPLORATION

Minerals of economic interest other than molybdenite were not observed in this belt by the present survey. However, at Senior Lake, massive coarse-grained and fairly continuous pyrite zones ranging from 10 cm to 3.8 cm in width were observed along both margins of a 30 cm wide feldspar porphyry dike lying in concordant contact with mafic metavolcanics.

On the north shore of Senior Lake, within the Bamaji Lake complex, a 15 cm wide, medium to coarsely recrystallized quartz vein over 12 m in length con-

tains up to 1 percent scattered disseminations of molybdenite. Analysis of a grab sample taken by the writer registered 0.36 percent molybdenum, and 0.61 percent bismuth (assay by Geoscience Laboratories, Ontario Geological Survey).

Contacts of the Fawthrop-Senior Lakes belt with granitic batholithic complexes may warrant a closer examination for additional possible molybdenite mineralization similar to that found at the Fawthrop Lake option of Madsen Red Lake Gold Mines Limited. Areas in which this belt is in contact with the Bamaji Lake complex are considered especially favourable for future detailed geological examinations.

The presence of mafic and ultramafic phases within the belt, about 4.8 km southeast of Fawthrop Lake is particularly notable and further investigation is clearly needed in order to delineate their extent and economic potential.

LANG LAKE BELT

The Lang Lake metavolcanic-metasedimentary belt was not mapped during Operation Pickle Lake. Lithologic and outcrop data for the Lang Lake belt has been compiled from previous maps prepared by Fenwick (1969, 1970) and Fenwick and Srivastava (1972). Several isolated outcrops and areas of mineralization were visited during the field season in an attempt to gain additional information on problems of particular interest. The Lang Lake belt is approximately 40 km long and varies from 8 to 11 km in width.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The mafic to intermediate volcanic rocks of the Lang Lake belt consist predominantly of massive mafic metavolcanics, foliated mafic metavolcanics, and amphibolite. Locally mafic tuffs have been noted and pillowed units are common.

FELSIC TO INTERMEDIATE METAVOLCANICS

Intermediate to felsic metavolcanics consisting of pyroclastics and massive to spherulitic flows form a lithologic unit up to 0.8 km in width on the south shore of Lang Lake. A unit of similar composition consisting of massive to foliated and locally tuffaceous felsic metavolcanics occurs along the southeast shore of Lang Lake and extends in a curvilinear arc from McVicar Lake to Lang Lake to Andy Lake. Minor amounts of pyroclastic felsic metavolcanics occur on a small unnamed lake approximately 1.6 km southeast of Semia Lake

and a second minor occurrence of felsic metavolcanic flows and pyroclastics occurs as small lens-shaped units approximately 1.6 km northeast of Jutzi Lake.

METASEDIMENTS

Minor amounts of metasediments occur throughout the belt as minor units intercalated with the metavolcanics. In the western portion of the belt these metasediments consist of the metamorphosed equivalents of greywacke, siltstone, and argillite. To the east metasediments become increasingly abundant and at the eastern extremity of the belt they are the dominant lithologic rock unit. The metasediments in the eastern portion of the belt consist of conglomerate, greywacke, and argillite. The conglomerate unit is notable and is 705 m wide west of Cannon Lake. The metasediments occur in the center of a structural syncline extrapolated from the western end of the belt and cover a surface area of approximately 18 km by 6 km.

IRON FORMATION

Throughout the Lang Lake belt thin units of iron formation, generally less than 6 m in width, are intercalated with the metasediments and metavolcanics. Using the previous mapping by Fenwick and aeromagnetic maps 894G and 904G (ODM-GSC 1960), several geophysically inferred iron formation units are indicated within the belt. These aeromagnetically indicated iron formations have a strike length up to several kilometres in length. The presence of a sulphide facies iron formation has been noted by Fenwick north and west of Saddle Lake in the western portion of the belt.

MAFIC TO INTERMEDIATE INTRUSIVE ROCKS

Sor-McVicar Lakes Intrusion

An early mafic sill or stock elongated east-west is present in the Sor-McVicar Lakes area. The Shonia Lake-McVicar Lake felsic intrusion divides the mafic body into two parts. The western portion is approximately 4 km long and 1.6 km wide. The eastern portion is approximately 9.7 km long and varies from 0.8 to 2.4 km in width. The mafic intrusion varies in composition from gabbro and diorite to anorthosite and anorthositic gabbro. Fenwick (1970) reported inclusions of gabbro and anorthosite in the mafic metavolcanics but field evidence relating these inclusions to the mafic intrusion is lacking.

Otoskwin River Stock

A prominent aeromagnetic high on Map 904G (ODM-GSC 1960) was investigated by shoreline outcrop examination along the Otoskwin River and several short land traverses normal to the river. Outcrop density is approximately 1 to 2 percent. Previous mapping of this stock (Emslie 1960) indicated an intrusive stock of gabbro to diorite composition. The present mapping disclosed a stock-like body composed of diorite to granodiorite, the shape of which is outlined approximately by the 61 000 gamma contour on 1 inch to 1 mile scale aeromagnetic map 904G (ODM-GSC 1960).

The rock exposures are dark brown to reddish black on outcrop surfaces and sampling is often difficult due to the deep penetration of weathering which gives a crumbly loose aggregate of feldspar, biotite, magnetite, and amphibole crystals. Prospect trenches dug by Ben Ohman have indicated that the depth of weathering in places may be at least 0.6 m in depth.

On fresh surface the rocks are dark grey to reddish brown and range from fine to coarse grained, equigranular and porphyritic. Field mapping has indicated an increase in biotite content towards the center of the body where the biotite occurs as fairly large grains in a biotite-hornblende quartz diorite. The intrusion may possibly be zoned but sufficient thin section data is lacking to adequately prove or disprove this possibility.

In thin section the rock is fine to coarse grained, with an inequigranular, seriate, hypidiomorphic texture. A visual estimate of the mode is microcline 0-15 percent, plagioclase (sodic to calcic andesine) 30-75 percent, biotite 5-25 percent, hornblende 0-25 percent, quartz 0-25 percent, with accessory apatite 0-3 percent, magnetite 2-15 percent, zircon trace, epidote 0-5 percent. Myrmekitic intergrowths of quartz and feldspar in amounts less than 1 percent were noted in some tiny interstitial grains. The prominent circular aeromagnetic feature delineating the intrusion is due to the relatively high magnetite content of the rock which averages 5 percent or more. The larger plagioclase grains often display undulatory extinction, bent twin lamellae, and microfracturing and faulting. One thin section displayed good cataclastic textures in a narrow zone which consists of larger oblate grains of strained plagioclase in a groundmass of recrystallized fine grained quartz and plagioclase. The term cataclasite would probably best describe this rock texture (Higgins 1971, p.3, 6).

Some of the larger plagioclase grains display a weak zoning and tiny poikiolitic inclusions of plagioclase in biotite were noted. The amphibole grains display good pleochroism from a light yellow-green to pale green. Quartz is always interstitial and fills the interstices between anhedral to euhedral plagioclase grains. Microcline feldspar occurs between grains of plagioclase and is part of the interstitial groundmass.

A fine grained dark brown to brownish black rock occurs as possible dikes or inclusions within the margins of the normally medium to coarse grain stock. The rock has sharp contacts with the coarse grained phases and on weathered surface it has a reddish brown colour. In thin section the mode of the dike rock is visually estimated to be: oblate grains of orthopyroxene 35-40 percent, plagioclase (labradorite) 50-60 percent, biotite approximately 5 percent, and magnetite with trace ilmenite 5 percent. Trace amounts of apatite and amphibole were noted. The texture is massive, fine-grained, equigranular, hypidiomorph-

ic. The pyroxene is optically positive and this would indicate the presence of enstatite.

Since the mineral assemblage represents a higher temperature phase than the enclosing medium to coarse grained rocks, this rock type is thought to be an earlier and possibly comagmatic phase of the intrusion that has been broken up and been incorporated as xenolithic inclusions. The rock type is best described as a norite (AGI 1972, p.484).

Age Relations Mafic blocks believed to be representative of mafic metavolcanics were found in the margins of the intrusion, and granitic pegmatite and aplite which are considered to be phases of the surrounding granite cut all lithologies of the stock. The intrusion is thus considered younger than the volcanic rocks of the Lang Lake metavolcanic-metasedimentary belt which closely borders the stock to the south, but older than the surrounding granite. A small body of migmatized mafic metavolcanics crosses the Otoskwin River just east of the eastern margin of the stock.

Structure Little structural data is available, however foliation measurements on the preferred orientation of feldspar suggest that the foliations very crudely follow the general outline of the stock. This may be in part, a primary feature.

FELDSPAR PORPHYRY

Located at the south end of Shonia Lake and extending south to McVicar Lake is a feldspar porphyry stock visually identified as trondhjemitic in composition. The rock in weathered outcrop is light brown to tan, and on fresh surface consists of approximately 45 to 60 percent milky-white saussuritized feldspar phenocrysts up to 1 cm in maximum length. The matrix is dark green to black and aphanitic. On slabbed surface the plagioclase phenocrysts have diffuse grain boundaries in contact with the enclosing matrix. These diffuse boundaries are probably due to alteration. In thin-section the original porphyritic texture is apparent, however, the pervasive alteration prevents an accurate determination of the plagioclase phenocryst composition. The phenocrysts are highly saussuritized and consist of a cloudy aggregate of zoisite with minor fine-grained quartz. The groundmass is a fine-grained mixture of chlorite, zoisite, and carbonate. The presence of ankerite veins in the general area and brownish weathering surface would suggest the possibility that the carbonate is ankerite (Fenwick 1970).

On a small lake 2.8 km southeast of Semia Lake and along the south margin of the belt in close contact with the mafic metavolcanics (Fenwick 1970) a

OGS 10 262

Photo 5–Photomicrograph of protomylonite from south contact of Lang Lake belt. Sample from edge of small pond approximately 3.2 km southeast of Semia Lake.

unit mapped as feldspar porphyry was located. One traverse indicated the unit to be about 300 m wide. In outcrop the rock is light brown to greenish brown to grey white, well foliated and contains feldspar phenocrysts up to 6 mm in long dimension. On fresh surface the rock is grey green and has a well developed porphyritic and foliated texture. In thin-section (Photo 5) the "phenocrysts" were observed to be porphyroclasts, and the rock was seen to be a protomylonite (Higgins 1971, p.3). The porphyroclasts comprise 45-60 percent of the rock and are of oligoclase composition. The porphyroclasts consist of oblate feldspar grains displaying microfaulting, wavy extinction, and bent twin lamellae. The porphyroclasts are enclosed in a ground mass consisting of fine grained quartz with wavy extinction and sutured grain boundaries, chlorite, and sericite. Minor epidote-zoisite is also present. Quartz makes up 25-35 percent of the rock and chlorite and sericite 10-20 percent. The platy minerals are oriented and preferentially concentrated into bands which in conjunction with the fine-grained quartz give the rock a well developed schistosity.

Since the original texture has been obliterated by tectonism it could not be ascertained whether the rock is more closely related to the nearby granitic terrain or originated as an early, high level, felsic intrusion, emplaced marginally to the Lang Lake belt possibly consanguineous with felsic volcanic processes. The rock was visually identified as trondhjemite.

Some of the basalt porphyry units reported by Pickle Patricia Explorers Limited (Meen Lake area, Assessment Files Research Office, Ontario Geological Survey) in diamond drill holes close to the porphyroclastic outcrop may represent zones of cataclasis in the metavolcanics. Additional work appears warranted to delineate this unit.

MAFIC DIKE ROCKS

Fenwick (1970) reported the presence of lamprophyre and diabase dikes.

Structural Geology

The major structure influencing the Lang Lake belt is an isoclinally folded syncline striking about N70E and plunging 40-60°E. The structural interpretation is based on pillow top data and graded bedding. The axis of the syncline is located between Boyes and Lang Lakes in the western portion of the area and in the center of the metasedimentary sequence in the eastern portion.

A marked curvature in the outcrop pattern of a felsic metavolcanic unit west of Shonia Lake and inflections in the measured foliations would suggest folding in this area.

Fenwick (1969, 1970) measured two distinct foliations. One foliation parallels the primary features such as bedding, and the other trends about N30W and is steeply dipping. Fenwick (1970) related the northwest-trending foliation to the quartz porphyry intrusion.

The prominent cataclastic-mylonitic textures observed in the sample collected marginally to the southeast trending lobe of the Lang Lake belt suggest considerable tectonic activity in the area between the Lang Lake and the Meen-Dempster Lakes belt. The lack of data precludes a definite interpretation of the relationship between the two belts. Where examined microscopically, similar cataclastic textures were noted in granitic rocks that were collected along the northern margin of the Meen-Dempster Lakes belt. The Lang Lake and Meen-Dempster Lakes belts are presently separated by faulting and could even be faulted segments of a formerly continuous belt.

Economic Geology

Only brief attention was directed towards the economic aspects of the Lang Lake belt during Operation Pickle Lake. Information relating to the mineral exploration history and economic geology are well documented within the preliminary maps of Fenwick (1969, 1970) and Fenwick and Srivastava (1972). A property visit of one-half day's duration was made to the McVicar Lake copper-nickel prospect.

PROPERTY DESCRIPTIONS

McVicar Lake Copper-Nickel Prospect

The McVicar Lake prospect is situated approximately 3.2 km due east of McVicar Lake. Access is most effectively gained by a foot path about 1.6 km in length commencing at the west end of a narrow lake called "Flat Lake". This lake can accommodate landings of float-equipped fixed-wing aircraft.

History Considerable exploration activity in the Lang Lake belt has been expended in assessing the copper-nickel mineralization associated with a large metagabbroic pluton in the McVicar Lake area. Initial interest was recorded in 1959 by Kenlew Mines Limited through trenching, and ten diamond drill holes totalling 582 m (Shklanka 1969, p.178). Later in 1961, this company continued exploration work in the form of magnetic, electromagnetic, and self-potential geophysical surveys. Late in 1961, 58 claims were optioned by Kerr Addison Gold Mines Limited. Magnetic and electromagnetic surveys established an anomalous zone about 300 m in strike length (Assessment Files Research Office, Ontario Geological Survey, Toronto). Two diamond drill holes (133 m) intersected copper-nickel mineralization with best assays of 0.96 percent copper over 0.98 m and 0.26 percent nickel over 1.5 m (Assessment Files Research Office, Ontario Geological Survey, Toronto). More recently, during 1968-1969, New Jersey Zinc Exploration Company (Canada) Limited optioned 60 claims and investigated the copper-nickel possibilities of the area in the vicinity of the known showings. Magnetic, electromagnetic, geological, geochemical surveys, trenching, and diamond drilling (five holes totalling 213 m) disclosed the presence of mineralization of low tonnage and subeconomic grade (Assessment Files Research Office, Ontario Geological Survey, Toronto). This claim group was open for staking during the time of this survey.

Geology The major zone of mineralization (claim KRL 62576) occurs along a southeast to east trending brecciated, sheared contact situated between a large metagabbro pluton and mafic metavolcanics to the north. The trenched areas are greatly obscured by limonitic stains rendering it difficult to unravel exact relationships. Host rocks of mineralization consist predominantly of coarse-grained, massive, porphyritic, dark greenish-black (fresh surface) metagabbro. Light greenish white plagioclase phenocrysts typically measure about 5 mm in diameter and range up to 15 mm in diameter. Generally these phenocrysts comprise between 20 and 30 percent of the rock. A fine-grained, equigranular metagabbro phase was noted to occur locally, intruded into the porphyritic

unit. The adjacent mafic metavolcanic rocks dip to the south at approximately 65 degrees. Fenwick (1970) indicated that mafic pyroclastic rocks varying from tuff to pyroclastic breccia are exposed contiguous to the main mineralized zone although these rocks could represent the products of tectonism. Sparse dikes of light pink to white weathering, massive, leucocratic, slightly porphyritic tron-dhjemite were observed to represent the latest intrusive event in the immediate area.

Mineralization The observed mineralization appears to occur in two distinct modes:

(1) as massive sulphide segregations which almost exclusively consist of fine-grained to coarse-grained pyrrhotite; and,
(2) as disseminated and fracture fillings of pyrrhotite and chalcopyrite in porphyritic and equigranular metagabbro.

The former category occurs in relatively large lenticular masses varying up to 1.5 m in length. Blocky to ovoid fragments of both metagabbro phases are locally discernible in the massive sulphide sections. Some specimens of the massive sulphide mineralization display a peculiar cross-hatching, apparently defined by two fracture sets intersecting approximately at right angles. In the latter category the sulphide content is considerably lower and locally approaches 20 percent of the host rock. Both pyrrhotite and chalcopyrite occur as fine to medium size grains disseminated amongst the silicate phases.

A series of six grab samples representative of the variation in type and content of the sulphide mineralization were selected by the writer for analysis by the Geoscience Laboratories, Ontario Geological Survey, Toronto, and are presented in Table 3 accompanied by individual specimen descriptions. The results generally confirm the wide range in copper and nickel values earlier observed by K.G. Fenwick (personal communication). Two massive sulphide specimens returned the highest nickel values of 0.89 and 1.48 percent with palladium values up to 0.03 ounces per ton. Polished section microscopy and X-ray diffractometry of the specimen containing the highest nickel value showed the nickel phase to be violarite ($(Ni, Fe)_3S_4$, not pentlandite as was previously suspected. Photo 6 illustrates the observed mode of occurrence of violarite, i.e., as narrow veinlets or seams showing cubic cleavage and situated between coarsely crystalline pyrrhotite grains. The latter mineral often shows prominent basal parting. Violarite commonly occurs as a replacement of pentlandite as exemplified by the UMEX Thierry deposit. No relict pentlandite was indicated in the cursory laboratory investigation. No other sulphide phases of any importance were detected although high trace concentrations of cobalt in some samples (up to 1200 ppm) may reflect erratic grains of siegenite, a nickel bearing variety of linnaeite (Co_3S_4), a mineral crystallographically related to violarite. Emission spectroscopic analyses on all grab specimens indicated an absence of any other metals of economic importance.

TABLE 3 ASSAYS OF SELECTED MINERALIZED GRAB SAMPLES, McVICAR LAKE COPPER - NICKEL PROSPECT, LANG LAKE BELT.

Sample Number	Copper	Nickel	Cobalt	Platinum*	Palladium*	Gold*	Silver*
CC9-1	0.12%	0.20%	N.D.	none detected	trace < 0.005	trace	trace
CC9-2	1.10	N.D.	N.D.	none detected	trace < 0.005	0.01	trace
CC9-3	2.12	0.14	N.D.	trace 0.005	trace < 0.005	0.01	0.31
CC9-4	0.10	0.19	N.D.	none detected	none detected	trace	trace
CC9-5	0.03	1.48	0.12%	none detected	0.03	trace	trace
CC9-6	0.08	0.89	0.07	none detected	trace < 0.005	trace	trace

* ounces per ton
N.D. = Not Determined
Assays by Geoscience Laboratories, Ontario Geological Survey.

Specimen Descriptions

CC9-1 Massive porphyritic metagabbro containing blocky to ovoid phenocrysts of plagioclase up to 10 mm in length. Sulphide mineralization predominately consists of irregular interstitial disseminated pyrrhotite grains and blebs, which often partially to completely enclose contiguous silicate phases. Sparse chalcopyrite grains occur with the pyrrhotite. More rarely, hairline fractures filled with both sulphide minerals traverse across the rock, locally cutting plagioclase phenocrysts. Total sulphide content approx. 8 percent.

CC9-2 Nature of mineralization and type of host rock very similar to CC9-1 except that chalcopyrite is dominant. Total sulphides approx. 8-10 percent.

CC9-3 Braided network of chalcopyrite and minor pyrrhotite stringers completely surrounding individual granulated silicate phases and larger (5 cm) ovoid-shaped fine-grained metagabbroic? fragments. Mineralization appears to have infiltrated a breccia matrix. Total sulphide content about 20 percent.

CC9-4 Localized irregular veinlets and blebs of pyrrhotite and chalcopyrite, contained within a fine-grained massive phase of the metagabbro (pyrrhotite 8 percent, chalcopyrite 1 percent).

CC9-5 Coarse-grained massive pyrrhotite containing diminutive chalcopyrite grains and black ovoid to elongate host rock fragments. A peculiar cross-hatched pattern often obvious, possibly due to basal parting of pyrrhotite. Approximately 90-95 percent sulphides.

CC9-6 Medium-grained massive pyrrhotite, occasional speck of chalcopyrite. Approximately 90-95 percent sulphides.

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Photo 6–Photomicrograph of polished section (55X) showing seam of violarite with coarsely crystalline pyrrhotite host. Black areas represent chloritic gangue. McVicar Lake Cu-Ni prospect, Lang Lake belt.

Ben Ohman

The late Ben Ohman of Pickle Lake held a claim group centred over the Otoskwin River pluton during the summer of 1972. A sediment sample collected by Ohman along the Otoskwin River was analyzed by the Geoscience Laboratories, Ontario Geological Survey, and found to contain 0.02 ounces gold per ton, 1.5 ounces silver per ton, with traces of copper and nickel.

BAMAJI-FRY LAKES BELT

The Bamaji-Fry Lakes metavolcanic-metasedimentary belt extends from Wesleyan Lake 27 km to Burley Lake where it is warped about the Obaskaka

Lake pluton. On the northwest side of the pluton, the Bamaji-Fry Lakes belt (Figure 8, Chart A, back pocket) merges with the Meen-Dempster Lakes belt, and on the south side merges with the Johnston Bay-Fry Lake belt. The north-south width of the belt ranges from 1.6 km in the west increasing to a maximum of 16 km in the central portion of the section and narrowing to 6.4 km in the eastern extremity where the belt merges with the Meen-Dempster Lakes belt. Access to this area is by float-equipped aircraft. A complex waterway system extends throughout this area which allows easy access to most parts of the belt.

The Bamaji-Fry Lakes belt was included in the reconnaissance mapping of Harding (1936). The Geological Survey of Canada conducted a regional mapping survey which also covers this area (Emslie 1960). More recently, Cochenour Willans Gold Mines Limited has completed detailed mapping of localized areas within the Fry Lake area (private geological maps, Cochenour Explorations Limited).

Rather extensive outcrop is present in the Wesleyan Lake section and the central section of the belt, being fairly continuous in many places and locally exceeding 30 percent of the surface areas. The various lakeshores have particularly good exposures. Outcrops decrease considerably west of Rockmere Lake, east of Fry Lake and at the northern terminus of the belt section.

The Bamaji-Fry Lakes belt consists of approximately 70 percent mafic to intermediate metavolcanics. Felsic to intermediate pyroclastic metavolcanics occur along the north side of Fry Lake, along the north shore of Bamaji Lake, and minor occurrences are present on Kaginot Lake. These felsic pyroclastics rarely comprise more than 10 percent of the total surface area of the metavolcanic-metasedimentary sequence. One sedimentary zone composed predominantly of conglomerate and greywacke occurs along the southern margin of the belt on Bamaji Lake. Another zone, composed essentially of greywacke and arkose, forms a thick lithological unit rimming the northeast edge of Fry Lake and extends northward in a curvilinear arc forming the eastern margin of the belt. Minor mafic intrusions or thick flow centres appear restricted to the southern portion of the belt near Bamaji Lake. A plagioclase porphyry pluton approximately 3.2 km by 0.8 km in size is located within the belt on the south edge of Fry Lake. Other felsic intrusions consist of quartz and/or plagioclase porphyry dikes trending parallel to east-west foliations and which are particularly numerous in the Moosetegon-Rockmere Lakes area just west of Fry Lake.

Structurally, the southern half of the belt displays generally eastward trending steeply dipping foliations which parallel the bedding. In the northern half of the belt, the strike of both the foliations and bedding bends around and trends northward toward the northern apex of the belt. Further investigations may reveal a fairly complex structure for this section of the belt. Macroscopic fold structures are clearly discernable on air photographs covering the Wesleyan Lake section of the belt, similar to the eastern extension of the Birch Lake-Uchi Lake belt (Fawthrop-Senior Lakes belt) west of Senior Lake. The Wesleyan Lake section is a shallow eastward plunging synform folded about an axis located west to northwest of Slate Falls. The Bamaji Lake complex intrudes the Wesleyan Lake section as porphyritic dikes which interdigitate with the metavolcanics. These porphyritic dikes which intrude the Wesleyan Lake syncline tend to parallel the east-trending foliations.

A prominent shear zone trends east-west through the north Bamaji-Rockmere-Moosetegon Lakes region. This has resulted in extensive local cataclasis of the Bamaji Lake complex intrusion in the area of North Bamaji Lake and of the mafic metavolcanics in the Rockmere-Moosetegon Lakes area.

Molybdenite mineralization as minor specks or clots is found occasionally on North Bamaji Lake within the sheared Bamaji Lake stock and within east-west trending quartz veins cutting the stock.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Fry Lake Section

The Fry Lake segment of the Bamaji-Fry Lakes belt is characterized by a predominance of foliated to massive and locally pillowed mafic to intermediate metavolcanics. Most commonly they are foliated and fine-grained hornblende-plagioclase amphibolites. The plagioclase is oligoclase-andesine averaging An_{30}, but in many places retrogressive alteration has destroyed the feldspar leaving a saussurite mixture of clinozoisite, chlorite and minor epidote in association with hornblende. In the Moosetegon-Rockmere Lakes area, chlorite is prevalent in the metavolcanics which have suffered extensive shearing. Apart from the sheared metavolvanics which display a very light greenish grey weathered surface, the fresh and weathered surfaces of most mafic metavolcanics vary from dark grey to lighter greenish grey.

Various local units of pillowed metavolcanics are present at Rockmere Lake and in the northwestern bays of Fry Lake. The most extensive development of pillowed metavolcanics is found along the southern half of Fry Lake. The pillows vary from balloon-shaped to more commonly stretched loaf-shaped, with sizes averaging 60 by 25 cm. Stretching of pillows varies in a north-south line normal to the Fry Lake stratigraphy but appears to be more extreme in an east-west central zone within the lake where length-width ratios of up to 6:1 are present. The relationship of the pillow stretching with possible structural deformation of the greenstone belt may be more clearly established with more detailed mapping. Pillow top determinations are best exposed in the southern part of Fry Lake where all indications suggest top orientations are to the south. On Fry Lake flow units have been tentatively distinguished on the basis of composition and texture. A distinctive plagioclase-porphyritic, intermediate to mafic metavolcanic unit trends eastward through the west-central part of Fry Lake. Such a unit may be suitable as marker horizon for establishing the stratigraphy in any future detailed study of the belt.

Major element whole rock chemical analyses may also be useful for a similar purpose. Analyses of selected samples taken from Fry Lake reveal that both undersaturated olivine tholeiites and oversaturated tholeiites comprise differ-

ent units within the stratigraphy of this section of the belt (see Appendix A).

The presence of intermediate to mafic pyroclastic deposits is very local, the best examples being observed northeast of Slate Falls. These are tuff to lapilli-tuff, very fine grained and thinly laminated with a dark greenish grey weathered surface. The lighter coloured lapilli fragments average 2 mm by 4 mm in size with some up to 2 mm by 10 mm and comprise about 20 percent of the units.

Wesleyan Lake Section

The Wesleyan Lake segment of the Bamaji-Fry Lakes belt is composed of a monotonous assemblage of mafic to intermediate metavolcanics. These metavolcanics are foliated and texturally vary from aphanitic to medium grained. A pillowed unit occurs on the Cat River just north of Slate Falls. The pillows at this location are characterized by size variation (average 46 cm by 10 cm) irregular shapes, light greenish grey weathered surfaces, and locally contain plagioclase phenocrysts set in a very fine grained matrix. Where observed, the phenocrysts are medium grained (1.0 to 5.0 mm) and constitute no more than 5 percent of the rock.

FELSIC TO INTERMEDIATE METAVOLCANICS

Pyroclastic deposits range from fine-grained tuff to agglomerate. These are distributed in a zone along the north shore of Bamaji Lake, and in two zones along the north and northwest margins of Fry Lake. The only other felsic pyroclastic occurrences of note are found at the southwest end of Kaginot Lake, but it is believed that they may be comparatively local units.

The pyroclastics along Bamaji Lake are typically very fine grained, thinly laminated with laminae being rather continuous. The origin of these deposits is more clearly evident by the presence, in some outcrops, of lapilli fragments averaging 5 cm by 12 mm and usually occupying 10 percent of the units. The size and percentage of such fragments are greatest at the northeast end of the lake where lapilli-tuff prevails. Southwestward along the north shore of Bamaji Lake, tuff deposits become more prominent concomitant with a decrease in clast size and number of the lapilli fragments until clasts are no longer visible on the outcrop surface. These tuffaceous deposits appear to be essentially intermediate (possibly dacitic) in composition. They usually have a light brownish grey weathered surface and dark grey fresh surface.

Northwest of Fry Lake, a felsic to intermediate pyroclastic zone is dominated by well laminated tuff. Approximately in the centre of the zone, a unit of coarse grained agglomerate plunges and is attenuated in an eastward direction. The whitish rounded ovoid fragments are medium to fine grained, averaging 30 by 15 cm in size and contrast slightly with the somewhat darker fine grained matrix. The fragments amount to about 25 percent of the exposed unit.

Further east on the north edge of Fry Lake, a zone of well bedded intermediate to felsic tuff deposits extends east for about 8 km with a width of up to 0.6

km. Feldspar- and quartz-bearing crystal tuffs are commonly observed in this zone, and some fine to medium grained angular quartz grains were noted at one outcrop. Mafic tuff and metasedimentary argillaceous units were observed to be intercalated within the zone, but form a rather minor proportion. The tuff in this zone is typically finely laminated with fine to medium grained feldspar grains locally concentrated in some horizons. At several localities, beds are quite distinct and are 15 cm or less in thickness. Very distinct grain gradations are seen, indicating top orientations are to the north. Coupled with the southward oriented pillows in the south half of Fry Lake, the data suggests the presence of an east-trending anticline through the central section of Fry Lake.

The compositions of the pyroclastics in both zones marginal to the north side of Fry Lake are observed to be intermediate (possibly dacitic). A visual estimate of the mode of one sample is: quartz 20 percent, plagioclase (An_{32}) 70 percent, biotite 10 percent, muscovite 1 percent, and minor opaque grains. Some samples contain up to 10 percent carbonate, mainly concentrated along foliation planes. The texture is finely foliated with aligned micas and stretched angular, close packed polygonalized quartz-plagioclase grains comprising the bulk of the matrix. Where quartz and plagioclase of medium to fine grain size are present, they appear ellipsoidal in shape and considerably strained, and a much finer matrix of quartz and plagioclase occurs within the strain shadows of these larger grains.

METASEDIMENTS

Apart from the two major metasedimentary zones along the north and south margins of the belt, sedimentary rocks are uncommon within the central portion of this belt, occurring only as minor intercalations within the metavolcanics. A pebble conglomerate, containing ellipsoidal pebbles of fine to medium grained quartz set in a chloritic argillite matrix, outcrops on an island in one of the northwest bays of Fry Lake. Considerable shearing has taken place with the result that the matrix is rather schistose. The pebbles, average 5 cm long by less than 1.3 cm wide, comprise about 20 percent of the unit, and are elongated in the plane of foliation at N80E, plunging 42 degrees east. The pebble conglomerate lies in contact with banded chert-magnetite iron formation.

The largest metasedimentary unit occurs marginal to the northeast side of the belt, striking east north of Fry Lake, and most probably linked with the Billett Lake-Teevin Lake metasedimentary zone towards the east. Metasediments within this zone range from arkose to feldspathic greywacke, and lithic greywackes. The grains are typically very fine to fine sand size, and include angular to subangular quartz and plagioclase. The plagioclase is dominantly andesine and varies in composition between different units from An_{32} to An_{45}. Biotite is consistently present and visually estimated to constitute from 5 to 20 percent of the metasediments.

Assemblages in this metasedimentary unit include the following:

1) sillimanite-biotite-garnet-plagioclase-quartz;
2) muscovite-zoisite-biotite-carbonate-plagioclase-quartz;
3) zoisite-biotite-plagioclase-quartz;
4) muscovite-biotite-plagioclase-quartz.

The coarsest clastic sedimentary rock observed in this unit is lithic greywacke with lithic quartz-feldspar (arkose) fragments of up to about 1 cm in diameter which comprise 25-30 percent of the rock. The most abundant lithology in the unit is feldspathic greywacke which in some units is garnetiferous. A visually estimated mode is quartz 60 percent, plagioclase (An_{45}) 15 percent, garnet 15 percent, sillimanite 5-10 percent, biotite 5 percent, and opaques 1 percent. An arkose with interstitial carbonate cement has a visually estimated mode of quartz 40 percent, plagioclase (An_{38}) 25 percent, carbonate 10 percent, biotite 5 percent, muscovite 5 percent, and opaques 1 percent. Bedding, where observed in the unit, trends parallel to the foliation. In most of these rocks there is a clearly developed foliation accentuated by the micas.

The other major unit of metasediments is located on the north shore and islands of Bamaji Lake extending southwestward to the entrance to North Bamaji Lake. The unit extends approximately 19 km along Bamaji Lake and terminates to the southwest in a migmatitized zone within the Bamaji-Blackstone batholith. To the east, the unit may or may not be continuous with the Drum Lake-Honderich Lake metasediments (see Johnston Bay-Fry Lake belt). The width of the Bamaji Lake unit averages 0.3-0.5 km but narrows considerably to the southwest. At the southwest end the metasediments continue for a short distance as an agmatitic migmatite zone. The zone appears in part to be confined along the length of Bamaji Lake by the felsic tuffaceous unit to the northwest and continuous or discontinuous mafic intrusive and mafic metavolcanic rocks to the southeast beyond which lies the batholith. The exposed metasediments are dominantly feldspathic greywacke to arkose. The southwest end of the exposed unit is pebbly greywacke grading westerly along strike to conglomerate.

The greywacke is typically fine grained, and principally composed of quartz, plagioclase, biotite and some muscovite. The bedding, trending parallel to the foliation, varies from less than 6 mm to 60 cm in thickness. Some flexuring and contortion is locally evident in these units.

The arkose is generally thin bedded with individual beds ranging from 1 mm to 2.5 cm. The mineralogy of the arkose is similar to that of the greywacke, but with a smaller mica component.

The pebbly greywacke consists of a fine grained greywacke matrix enclosing elongate trondhjemitic pebbles with an average size of 7.5 cm by 2.5 cm. Bedding, foliation, and pebble elongation have the same east trend. One representative measured trend of pebble elongation was N72E plunging 72 degrees NE. Some beds show a marked concentration of pebbles in contrast to adjacent beds. Generally, there is a westward increase in the proportion of pebbles to matrix. Pebbly greywackes contain pebbles comprising up to 25 percent of the exposed outcrop surface towards the east while further westward along strike, the conglomerates show pebble concentrations of 30 percent to 70 percent with variation between adjacent layers.

Westward, along the strike of the conglomerates, fine to medium grained trondhjemite clasts displaying mineral elongation continue to predominate but are associated with occasional mafic metavolcanic, greywacke and coarse grained quartzite clasts in that general order of abundance. Not all clast types are present at any one outcrop. The quartzite and greywacke clasts are of pebble size whereas those of trondhjemite and amphibolite range from pebble to

cobble size. All pebbles average 6.3 by 1.3 cm in size, cobbles range from 13 by 4 cm up to 90 by 8 cm. These sizes are representative of one of the more westerly outcrops in the zone where the pebble, and especially the cobble size clasts are considerably elongated. Clasts of cobble and pebble size are approximately equivalent in percentage of the outcrop surface and together comprise about 50 percent of the conglomerate unit. The matrix, though fine grained in the pebbly greywacke, is decidedly coarser in the westerly conglomerates and contains coarse-grained and granule-size minerals and lithic fragments as significant portions of the matrix.

The Bamaji Lake section has been interpreted as a synclinal structure although there is a lack of structural data. If this interpretation is correct, the conglomerate is probably the oldest stratigraphic unit present even though tectonic and magmatic events have confused the picture. The conglomeratic unit warrants further investigation to determine if it is a basal conglomerate deposited near the beginning of the deposition of the Bamaji Lake volcanic and sedimentary rocks.

IRON FORMATION

One exposure of banded chert-magnetite in association with pebble conglomerate, located on a small island on the north side of Fry Lake, was examined. The bands of chert-magnetite in this unit vary in width from 1 mm to over 1 cm and consist of very fine grained grey chert and black fine-grained magnetite. This outcrop of banded iron formation lies on a prominent linear aeromagnetic anomaly (Map 902G, ODM-GSC 1960). Diamond drilling by Cochenour Willans Gold Mines Limited, surface exposures, and aeromagnetic trends indicate that the occurrence of iron formation in the Fry Lake section is largely restricted to the area along the north side of Fry Lake and in an area northwest of Fry Lake. A curvilinear iron formation unit between Fry and Kaginot Lakes about 2.6 km long is indicated on the basis of aeromagnetic data (Maps 902G and 903G, ODM-GSC 1960).

MAFIC INTRUSIVE ROCKS

Mafic intrusive rocks occur intermittently along the southeast shore of Bamaji Lake and are located for the most part on the southeast side of the metasediments. It is uncertain whether there are several separate intrusions or a continuous unit along the margins of the lake. The rock is foliated to massive and composed of fine- to coarse-grained hornblende and plagioclase. Grain size varies dramatically across some outcrops and the significance of this textural change may be revealed with more detailed mapping.

The intrusive nature of this rock is locally indicated by the presence of medium to fine grained mafic dikes within the adjacent metasediments. A very coarse grained sample with a rather 'knobby' weathered surface was noted just east of the entrance to North Bamaji Lake. Here the hornblende crystals average 2.5 cm in diameter in a finer grained matrix and enclose a xenolithic frag-

ment of metasedimentary schist.

The only other mafic intrusion noted within this belt is a diorite body intruding the metasediments near the northern apex of the belt on an unnamed lake approximately 3.2 km northwest of Burley Lake. Fine grained meta-arkose fragments occur within this body. The extent of this intrusion is probably rather limited because the exposure consists of only one island outcrop at the extreme north end of the belt.

FELSIC INTRUSIVE ROCKS

Quartz, Feldspar and Quartz-Feldspar Porphyry

Felsic porphyry dikes are prolific in the Rockmere-Moosetegon Lakes area. They trend in an east-west direction, are steeply dipping, and have a pervasive foliation oriented east parallel to the foliation in the enclosing metavolcanics and zones of shearing in the Rockmere-Moosetegon area. These dikes appear to be related to the Bamaji Lake complex centered on North Bamaji Lake.

Feldspar-quartz and quartz porphyry are the predominant dike rocks, although an occasional dike has only feldspar phenocrysts. The general intrusive nature, texture and mineralogy of the dikes are similar to those further west in the Wesleyan Lake section and the Fawthrop-Senior Lakes belt. Feldspar and quartz phenocrysts in places constitute up to 30 percent of the rock. Quartz phenocrysts seem to be more prevalent in the dikes of this area than amongst those further west in the Wesleyan Lake area.

The dikes are often of uncertain width but exposures up to 12 m wide have been observed. In many cases the composition is quite homogeneous across the width of the dikes, but some dikes have variations in the proportion of quartz and feldspar phenocrysts across their exposed widths.

In the southeast corner of Fry Lake a feldspar porphyry pluton occurs which is approximately 3.2 km long and 0.8 km wide. The pluton is fairly homogeneous in texture and mineralogy throughout its observed extent. The plagioclase phenocrysts (Photo 7) are pale pinkish white on the weathered surface and pinkish on fresh surface. They are euhedral to subhedral and comprise approximately 15 to 20 percent of the rock. The phenocrysts are generally 2 to 5 mm in length, but may be as long as 10 mm. The matrix weathers grey and on a fresh surface is lighter grey. The matrix is generally aphanitic to very fine grained. A visual estimate of the mode gives quartz 30 percent, plagioclase phenocrysts (An_{28}) 20 percent, sericite 40 percent, calcite 5 percent, biotite 5 percent, and disseminated magnetite 1 percent. The plagioclase phenocrysts are partly altered to very fine sericite throughout and appear to have somewhat diffuse margins in contact with the matrix. Angular to subangular very fine quartz grains suspended in finer sericite flakes comprise the general matrix of the rock.

Although the pluton is generally massive, in some areas, especially close to the margins, an east-trending schistosity is present. This schistosity is probably due to shearing along the margins of the stock. At depth, the shearing has

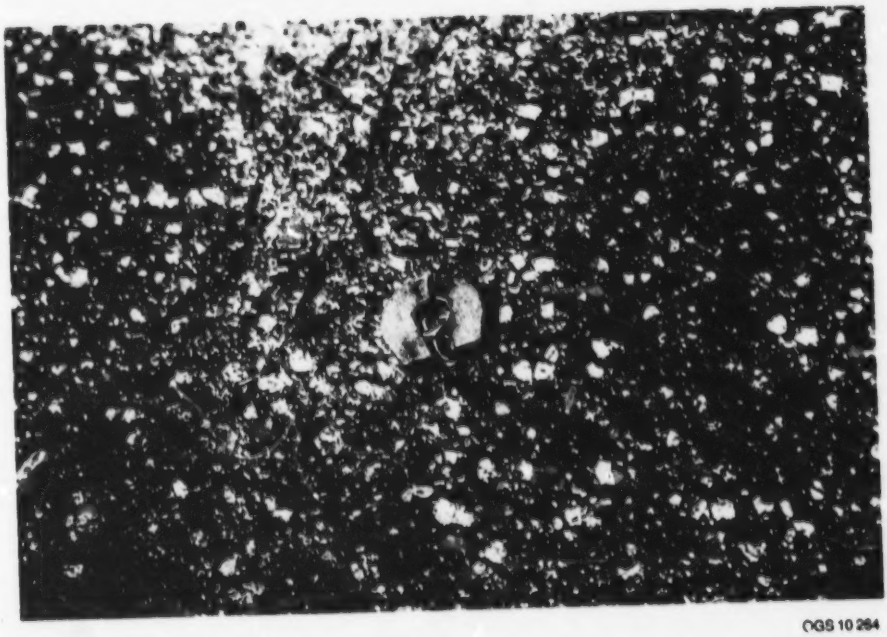

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Photo 7–Porphyritic texture of feldspar porphyry stock located in southeast corner of Bamaji-Fry Lakes belt.

been so extensive as to almost destroy the original texture of the rock. This feature was noted in an examination of some diamond drill core of Cochenour Willans Gold Mines Limited from the south margin of this body. The texture and general appearance of this porphyry pluton is somewhat different from the porphyritic dikes found in the east and west. This pluton may or may not be related to the period of felsic intrusive activity represented by the porphyry dikes and epizonal intrusion centered at North Bamaji Lake. A 1.5 cm chill zone conformable to the country rock schistosity has been observed in diamond drill core by Cochenour Willans Exploration Company (Diamond Drill Report 11, Assessment Files Research Office, Toronto).

The texture and composition of the porphyritic dikes within the Wesleyan Lake section are similar to those in the Fawthrop-Senior Lakes "greenstone" belt. The intrusions are sill-like and parallel the foliation within the enclosing metavolcanics. Over the exposed observable strike length they are generally of uniform width ranging from 30 cm to 2.2 m. Dikes and sills containing phenocrysts of both quartz and plagioclase are most common, but dikes or sills with only quartz or plagioclase phenocrysts are also present. The medium-grained feldspar phenocrysts (1 to 5 mm) are subhedral to euhedral while the quartz phenocrysts which range up to 6 mm in diameter are subrounded to subangu-

lar. The phenocrysts may comprise up to 50 percent of the dike material but more often comprise only 10 percent. The only apparent difference between the felsic intrusions present within the Fawthrop-Senior Lakes belt and those in the Wesleyan Lake section is an increase in number of dikes containing only quartz phenocrysts in the Wesleyan Lake section. Quartz porphyry dike and/or sill-like intrusions become even more prevalent further east at Rockmere Lake and easterly towards Relyea Lake.

Bamaji Lake Complex

The Bamaji Lake complex, a body of trondhjemite to quartz monzonite, extends about 30 km from the west end of Moosetegon Lake to the Fawthrop-Senior Lakes belt, and has a maximum width of 8 km. The complex is interpreted to be an epizonal intrusion related to the large granitic batholith north of the Bamaji-Fry Lakes "greenstone" belt. The complex is in turn intruded by the Bamaji-Blackstone batholith along its south margin in the vicinity of Bamaji Lake. The older relative age of the Bamaji Lake complex is indicated by agmatitic blocks of trondhjemite from the complex enclosed within coarse-grained granodiorite to quartz monzonite of the later Bamaji-Blackstone batholith. North-trending pegmatite dikes extend up to 2.2 km into the Bamaji Lake complex and appear to originate from the Bamaji-Blackstone batholith to the south. These pegmatites vary in composition and appear to grade from granodiorite at the margin of the complex to quartz monzonite deeper within the body.

The epizonal nature of the Bamaji Lake complex is inferred from the following field criteria:

(1) well developed porphyritic texture with fine-grained chilled groundmass near the contacts with metavolcanic-metasedimentary country rocks;

(2) associated cross-cutting porphyry dikes occurring marginally within the "greenstone" belt; and

(3) lack of consanguineous pegmatitic segregations within the complex.

The Bamaji Lake complex is possibly composite in character, although most of the rocks observed at North Bamaji Lake are remarkably homogeneous and trondhjemitic in composition. At the west end of North Bamaji Lake and in the vicinity of Senior Lake, there is some evidence for quartz diorite to quartz monzonite phases within the complex, with quartz monzonite being more common in the western portion or Senior Lake area of the complex.

The best exposed portion of the complex is fine- to medium-grained, generally cataclastic, very homogeneous trondhjemite centered on North Bamaji Lake and extending westward and northward to Wesleyan Lake. The fine-grained, locally porphyritic texture and light whitish-grey weathering surface are characteristic of this complex. A typical visually estimated mode is quartz 35 percent, plagioclase (An_{28}) 50 percent, biotite 10 percent, and muscovite 5 percent. Plagioclase of oligoclase composition varies from An_{24} to An_{28}. Generally, biotite exceeds muscovite, but in some cases, the above mica percentages

are reversed. To the west, the trondhjemitic phase of the intrusion includes microcline in amounts less than 5 percent.

The assumed northern margin of the complex lies between two outcrops on Senior Lake. Thin sections of these rocks show a possible slight decrease in quartz content in the granitic rocks to the north of the complex. At and near the northern margin of the complex approximately 25-30 percent microcline is present in some of the granitic rocks of the complex. Such an increase in microcline content was observed in an exposure of quartz-feldspar porphyry believed to be a phase of the Bamaji Lake complex. Porphyritic texture is common to phases of the complex but was not found in the granitic rocks north of the margin. Thin sections of the porphyry display a polygonized or granoblastic texture of quartz and feldspar. The rock has undergone deformation giving it a pronounced foliation and has then recrystallized. The complex has undergone metamorphism but the metamorphic grade is uncertain due to the lack of metamorphic indicator minerals.

A more detailed study of the textures, composition, extent and possible relationship to the granitic batholith to the north is warranted. Intrusions into the Bamaji Lake complex from the northern granitic batholith or of the Bamaji Lake complex into the northern granitic batholith were not observed. On a reconnaissance scale of mapping it was difficult to discern where the epizonal character of the Bamaji Lake intrusion stopped and the granitic rocks characteristic of deeper emplacement begin.

The Bamaji Lake complex is thought to partially enclose the Fawthrop-Senior Lakes belt, because rocks with compositions and porphyritic textures characteristic of the intrusion are present along its eastern contact.

The trondhjemitic North Bamaji Lake part of the complex grades into an increasingly porphyritic phase toward the contact with the Fry Lake metavolcanics and metasediments. At the observed contacts of metavolcanics-metasediments with the rocks of the Bamaji Lake complex, porphyritic textures similar to those found in dikes cutting the metavolcanics-metasediments are characteristic.

The trondhjemitic rocks generally display extensive cataclasis on North Bamaji Lake, however, local zones of more massive rock have evidently escaped the effects of shearing so widespread throughout the width of the lake and extending through the adjacent Moosetegon-Rockmere Lakes area.

In the area just south of Senior Lake between the two oppositely plunging synclines the composition of the rocks of the complex appear to be quartz diorite with andesine plagioclase (An_{36}) as opposed to the oligoclase plagioclase characteristic of the North Bamaji Lake area. Xenolithic inclusions within the complex, are often surrounded by feldspar porphyry phase of quartz diorite to granodiorite composition.

METAMORPHISM

Excluding obvious areas subjected to cataclasis, the overall metamorphic grade appears to range from lower greenschist to middle amphibolite facies of regional metamorphism. Epidote is stable in the presence of the oligoclase-andesine plagioclase found in the mafic metavolcanics. Upper amphibolite facies

grade may have been reached at least locally in the metagreywacke of the northern sector of the belt and is suggested by the presence of sillimanite, in the absence of muscovite and epidote.

The metamorphic grade of the belt is zoned from amphibolite and upper amphibolite facies at the margins to greenschist and lower greenschist facies in the central core and thicker portions of the belt. The grade of regional metamorphism is similar to that in the Fawthrop-Senior Lakes belt to the west.

Structural Geology

The Wesleyan Lake section of the Bamaji-Fry Lakes belt is an eastward plunging synform, most likely a syncline. The metavolcanic and felsic intrusive rocks have a pervasive east-trending foliation which dips at a shallow angle inward towards the axial plane of the fold and wraps around the indicated fold axis. Primary bedding was not observed in these rocks but in other areas of the Bamaji-Fry Lakes belt, foliation and bedding are parallel and it is assumed that this relationship persists here. The rather flat dipping foliations would indicate that this "greenstone" belt segment is a comparatively thin keel zone resting on top of the epizonal Bamaji Lake complex.

The structure of the Fry Lake section of the belt appears to be fairly complex. Steeply dipping foliations in the southern half of the belt defined by platy mineral alignment generally trend east. The variation in dips suggest the presence of possible synforms if the foliations and bedding remain parallel. Parasitic folds north of Rockmere Lake suggest that the major fold structures plunge approximately 60°E.

A major anticline in the central part of Fry Lake is the best defined fold structure in the belt. This isoclinal fold is overturned to the north with each limb dipping to the south. The anticlinal structure is indicated by the presence of south facing pillowed metavolcanics in the central portion of Fry Lake and north facing graded tuff deposits on the north side of Fry Lake. Sedimentary bedding and volcanic flows are commonly observed to trend subparallel to the east-west foliations in this southern half of the belt. Schistosities developed during metamorphism have not been subdivided from those developed during later shearing which may be at an angle to the earlier schistosities.

A major cataclastic zone trends through North Bamaji Lake and Rockmere-Moosetegon Lakes region of the belt. The mafic metavolcanics in the Rockmere-Moosetegon Lakes are highly sheared and schistose and contain chlorite and carbonate. The rocks in this area are highly schistose and much lighter green weathering in appearance than those in the other portions of the belt.

East of the Rockmere-Moosetegon Lakes area, the shearing becomes much less abundant. The epizonal intrusion centred on North Bamaji Lake has been subjected to this shearing and cataclasis and textural evidence of this shearing is present in outcrops across most of the north-south width of the lake.

Northwest of Fry Lake foliations in the extreme north end of the triangular shaped portion of the belt strike north toward the northern tip of the belt. The foliations dip consistently eastward across the width of that portion of the belt

ranging from 35° to 60° and averaging 45°. Mineral lineations show a general eastward plunge.

The greatest change in foliation and bedding orientations occurs in the vicinity of the felsic metavolcanics zone northwest of Fry Lake. In this area the foliation swings from east-west in the south to northward in the northern triangle of the belt. Further detailed structural measurements are needed to help resolve the complexity of the structure of this belt.

The Wesleyan Lake greenstone belt segment has been nearly severed from the metavolcanics of the Fry Lake greenstone section north of Slate Falls by the intrusion of the Bamaji Lake complex. The nearly complete separation and extensive interfingering of the greenstone belt and quartz-feldspar intrusive rocks north of Slate Falls is related to emplacement of the epizonal felsic Bamaji Lake complex. An attempt to display the extent of this interfingering was made by Harding (1936).

In summation geological data is lacking for a precise structural interpretation of the Bamaji-Fry Lakes belt. In the author's (Sage) opinion the belt is an isoclinally folded syncline. The north flank of this belt has been modified by pinching of the supracrustal rocks against the Cat Lake granitic terrain to the northwest by the diapiric rise of the Obaskaka Lake stock. This pinching formed the north-trending, tapering appendage to the belt which is also likely to be a synformal structure. The anticlinal structure on the north side of Fry lake on the north margin of the Bamaji-Fry Lakes belt is interpreted by the author (Sage) to be a local feature generated by lateral compression associated with expansion of felsic magma of the Obaskaka Lake stock during its diapiric rise into the supracrustal rocks at the time of emplacement.

Economic Geology

The Bamaji-Fry Lakes area is well known for both an abundance and diversity of metalliferous mineralized occurrences and prospects. Documented metal associations are quite varied and include Au, Au-Ag, Au-Ag-Cu-Pb-Zn-Sb, Au-Cu-Zn-Pb-Mo, Mo-Cu-Bi ± Ag ± Au, Cu-Pb-Zn, and U-Th-Au ± Ag.

Early exploration in this area focussed on the gold potential. Prospecting interest was heightened in 1934 by the discovery of gold on the Williams-Connell-Stirrett property, situated approximately 4.8 km northeast of Slate Falls. On the northwestern shore of Fry Lake a quartz vein mineralized with pyrite was staked by Connell Mining and Exploration Company in 1935 (Harding 1936, p.69). A grab sample selected by Harding assayed 0.22 ounces gold per ton. Later in 1946 Flicka Red Lake Gold Mines Limited acquired this property. Grab samples disclosed values up to 0.25 ounces gold per ton (Resident Geologist's Files, Ministry of Natural Resources, Red Lake). In 1965, Dome Mines Limited and Sigma Mines (Quebec) Limited jointly examined a gold-silver prospect at the eastern end of North Bamaji Lake. Trenching and sampling disclosed insignificant values of these metals.

Recent years have witnessed intense mineral exploration activity based primarily upon a search for volcanogenic massive sulphide deposits and for molybdenum and uranium to a lesser degree. In 1954, uranium mineralization

was discovered south of Moosetegon Lake by McCombe Exploration Limited. Further investigation ensued in 1968 by Kirkland Townsite Gold Mines Limited through airborne spectrometer survey, geological mapping and trenching (File 63.2510, Assessment Files Research Office, Ontario Geological Survey, Toronto). Recently, in 1971, R. Knappet indicated that some favourable gold values accompany the uranium mineralization (H.L. King, formerly Resident Geologist, Ontario Ministry of Natural Resources, Kenora, personal communication). R. Knappet additionally investigated a small copper-silver occurrence in sheared mafic metavolcanics in the same year (H.L. King, personal communication). This mineralization, which gave best assays of 0.39 percent copper and 0.38 ounces silver per ton (H.L. King, personal communication) is located about 0.8 km due south of the easternmost extremity of North Bamaji Lake.

From 1969 to 1973, Selco Exploration Company Limited and Cochenour Willans Gold Mines Limited were engaged in a joint program designed to assess the mineral potential of the Bamaji Lake-Jacknife Lake-Kawashe Lake area. This program involved an airborne electromagnetic-magnetic survey (1412 km^2), ground electromagnetic and magnetic surveys, geological mapping, geochemical sampling, and considerable diamond drilling totalling 4487 m. During 1966-1968, Cochenour Willans Gold Mines Limited examined two prospects near Slate Falls, i.e., the Sanderson option, and the Loon molybdenum option. These prospects are described in detail in the following section.

In 1970, C.C. Huston Partnership sank ten diamond drill holes totalling 319 m in the Drum Lake area but intersected no economic mineralization (Diamond Drill Reports 10, 11, and 12, Assessment Files Research Office, Ontario Geological Survey, Toronto). In 1971, Union Miniere Explorations and Mining Corporation Limited carried out an airborne electromagnetic-magnetic survey over the Bamaji-Fry Lakes belt and the Fawthrop-Senior Lakes belt (E. Reeve, UMEX, personal communication).

A striking characteristic of the Bamaji Lake complex lies in the widespread occurrence of discontinuous quartz veins and veinlets subparallel and concordant to the east-trending penetrative foliation. Molybdenite mineralization, associated chiefly with the quartz segregations, was demonstrated by the present survey to be equally ubiquitous. Commonly, this mineralization occurs as fine-grained, disseminated clots and flecks and occasionally as narrow seams. Disseminated to locally podiform pyrite and/or chalcopyrite intermittently accompany the molybdenite. Also notable is the presence of sparse disseminated molybdenite flakes within the trondhjemite itself.

In the east-central section of North Bamaji Lake, approximately 1.5 km southeast of Slate Falls, a small island contains mineralized quartz veins typical of the Bamaji Lake complex. Very fine grained molybdenite, accompanied locally with fine-grained purple fluorite and pyrite, occurs within a medium to coarse-grained quartz veinlet less than 25 cm in width. Borders of the vein consist of sheared sericitic masses and concentrations of pale whitish feldspar. Malachite and very sparse azurite staining was noted in one of the veins. Each of the mineralized components constitutes less than one percent of the vein. A grab sample taken by the writer and analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained 0.14 percent molybdenum, 0.10 to 0.20 percent fluorine, and traces of bismuth. Elsewhere, in the area, veins containing fluorite were not encountered.

The three most notable mineral occurrences were briefly examined by the present survey and are described in some detail below.

PROPERTY DESCRIPTIONS

Bamaji Uranium Occurrences

The region between Moosetegon Lake and the eastern end of North Bamaji Lake has been the scene of intermittant uranium exploration over the last 20 years. Geologically, this area straddles the contact between the Bamaji Lake complex and the Bamaji-Fry Lakes metavolcanic-metasedimentary belt, the latter being characterized in this area by *lit-par-lit* injection, amphibolitic grade contact metamorphism, and the presence of several lineaments of regional extent. Although several radioactive anomalies exist in the general area (H.L. King, formerly Resident Geologist, Ontario Ministry of Natural Resources, Kenora, personal communication), detailed examination by the present survey focused upon two prime occurrences, termed the No. 1 Showing, and the No. 2 Showing (File 63.2510, Assessment Files Research Office, Ontario Geological Survey, Toronto). These occurrences, respectively situated on claims PA43842 and PA43845 of the former Kirkland Townsite Gold Mines Limited property, are regionally located between two prominent *en echelon* lineaments, trending approximately N60E. These major features are traceable for about 5 km commencing from a small unnamed lake south of Moosetegon Lake westward to the end of North Bamaji Lake.

Most exploration activity has centered around the No. 1 Showing on claim PA43842. In 1954, McCombe Mining and Exploration Limited carried out trenching and diamond drilling (11 holes totalling 172 m). An assay by H.D. Carlson of the Ontario Geological Survey indicated 0.25 percent U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto). In 1968, Kirkland Townsite Gold Mines Limited continued with further trenching, detailed geological mapping, and an airborne spectrometer survey of the area in the vicinity of the two showings, covering approximately 5 km^2 (File 63.2510, Assessment Files Research Office, Ontario Geological Survey, Toronto). R. Knappett in 1971 staked and re-investigated both showings and reported gold values up to 0.52 ounces per ton (H.L. King, personal communication). Access to the No. 1 Showing, located at the southwest end of a small unnamed lake directly south of Moosetegon Lake, can be gained by a 0.8 km traverse from Bamaji Lake. A trail which commences at the extreme eastern end of North Bamaji Lake provides fair access to the No. 2 Showing. No further activity has been recorded on these properties since R. Knappett's claim-group lapsed in 1971.

Geology. The No. 1 Showing is contained within a relatively narrow east-trending, vertically dipping shear zone, exposed for a distance of 268 m. This shear zone is marked by a short cliff which can be observed on 1 inch to 1 mile scale

aerial photographs of the area. It can clearly be seen that this shear zone trends with an angular discordancy of about 15 degrees to the two N60E trending regional lineaments described in the previous section. Relationship of the shear zone to these lineaments is unknown. The host rocks consist predominantly of foliated, occasionally pillowed, fine-grained to medium-grained amphibolitized mafic metavolcanics, heavily intruded by *lit-par-lit* dikes and small bodies of massive to foliated, medium-grained, light-grey (fresh surface) biotite, and muscovite-biotite trondhjemite. Adjacent to the shear zone, which reaches a maximum width of about 1.8 m, the wall rocks are locally dominated by a pyrite-bearing muscovite quartzofeldspathic schist which appears to be the sheared, altered equivalent of biotite trondhjemite. The latter rock type, which greatly resembles that of the Bamaji Lake complex, becomes progressively more schistose, pyritic and muscovitic towards the shear zone. Within the shear zone, a characteristic, highly carbonatized fault breccia composed of mafic, chloritic fragments imbedded in a finer grained, more readily disintegrated matrix of carbonate ± actinolite ± chlorite ± biotite occurs intermittantly along the exposed length. The carbonate is light brown on fresh surface and is possibly sideritic in composition. Actinolite often occurs as coarse-grained, radiating dark-green (fresh surface) fibrous aggregates. The geology of the immediate area around the No. 1 Showing is illustrated in Figure 9.

The No. 2 Showing is situated along the contact of amphibolitized mafic metavolcanics and trondhjemitic rocks of the Bamaji Lake complex. The immediate host rock consists of leucocratic medium-grained creamy-weathering, massive to foliated, equigranular to locally porphyritic trondhjemite. Quartz phenocrysts up to 5 mm in diameter are especially prominent near the mineralized zone. Foliation within the host trondhjemite becomes perceptibly more intense close to the shear zone.

Similar to the No. 1 Showing, the mineralization is confined to a 0.6 m wide shear zone trending about N80E and dipping 40°N. Thin actinolite-biotite laminae appear to be controlled by shears *en echelon* within this zone. Individually, these laminae, which rarely exceed 4 cm width and average about 1 cm, are typified by a crude mineralogical zonation. Actinolite tends to dominate although a thin carapace of fine-grained biotite and disseminated pyrite is invariably present. Usually a dark brown alteration halo occurs immediately adjacent to these veinlets. Disseminated fine-grained pyrite (?) appears to gradually increase to 5-10 percent near these veinlets.

Mineralization (No. 1 Showing). The significant uranium, thorium, gold and silver values indicated in Table 4 are invariably correlated with bands of highly sheared pyritic sericite schist which intermittantly occur along the exposed 240 m strike length of the shear zone. These bands contain up to 30 percent fine-grained disseminated pyrite and are characterized by both rusty limonitic and light yellow staining. The latter colouration is probably indicative of secondary uranium minerals such as carnotite. The highest radioactivity readings (geiger counter) of 950 counts per minute were recorded over these bands.

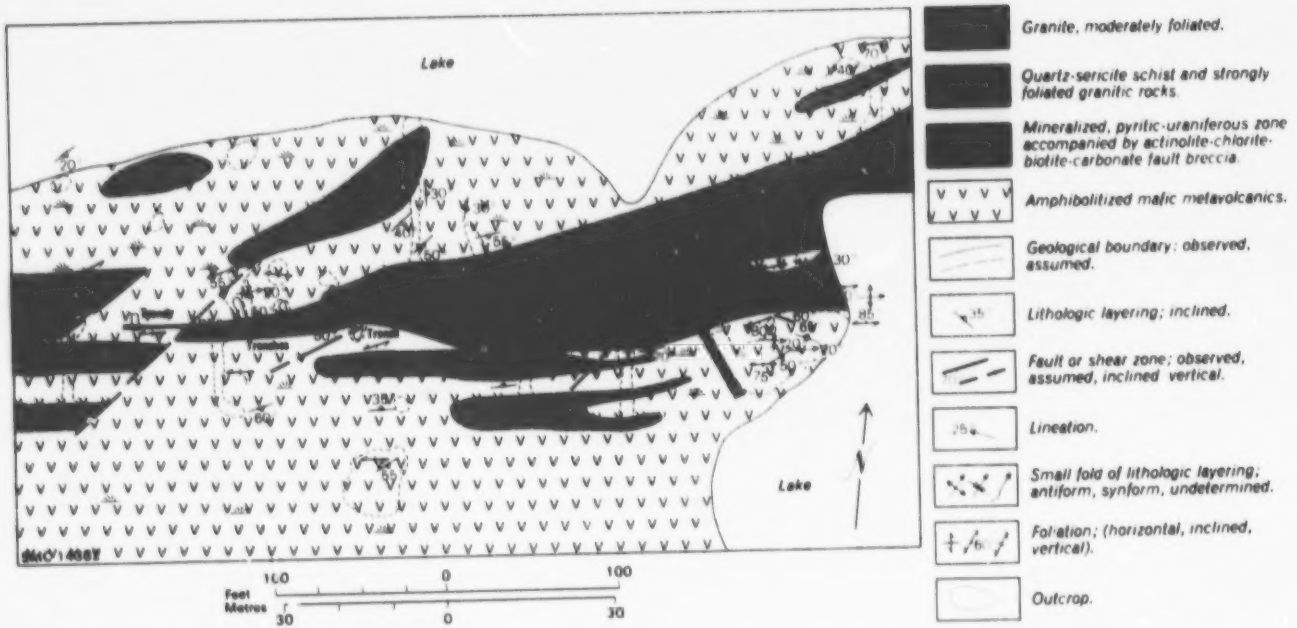


Figure 9–Geology of Bamaji Lake uranium-thorium occurrence, No. 1 Showing. Modified from map by Kirkland Townsite Gold Mines Limited (file 63.2510, Assessment Files Research Office, Ontario Geological Survey, Toronto).

The mineralized zone is often sharply bounded to the north by the carbonate fault-breccia unit. Within certain areas of the pyritic zones, black "sooty", very fine-grained masses amd seams of a lightweight friable substance are apparent. When strongly heated, this black material gives off considerable water and then burns in air emitting sulphur dioxide fumes. The residue, after strong heating, was found to be comprised of ferric oxide. X-ray diffraction patterns did not give a clear identification, although lines characteristic of goethite and marcasite were recognized.

The uranium mineral(s) could not be separated for unequivocal identification. A cut face of a specimen indicating the highest radioactivity detected in the field was exposed to X-ray sensitive film for 24 hours. The resulting autoradiograph indicated local faint diffuse darkening of the film. The radioactive source appeared to be extremely fine-grained and impossible to separate. It is suspected that uranothorite and/or uranite are present in very small quantities. Table 4 indicates that significant gold values (samples HCG9-14A, HCG9-17) and minor silver values occur within the pyritic sericite schist. These results confirm similar values obtained by R. Knappett. Emission spectroscopic analysis on all grab samples in Table 4 indicated an absence of significant quantities of other economically important elements.

Mineralization (No. 2 Showing). Geiger counter readings indicate that the bulk of uranium-thorium mineralization is confined to the actinolite-biotite-pyrite veinlets. The highest readings (1200 counts per minute) were attained on surfaces parallel to the outer biotite zones of such veinlets. No uranium minerals could be detected either by field or laboratory methods. It appears that the uranium and thorium is either present in a dominantly metamict state or occurs as diminutive inclusions within the fine-grained biotite.

Loon Molybdenite Prospect

The most spectacular molybdenite mineralization found to date within the Bamaji Lake complex is well exposed on the largest island in North Bamaji Lake and was discovered by the Loon family of nearby Slate Falls in the early 1960s. Cochenour Willans Gold Mines Limited optioned the claim-group in 1965 and proceeded with stripping, trenching, diamond drilling, and geological mapping both on the group and in the general North Bamaji Lake area. Twelve diamond drill holes totalling 785.2 m intersected generally subeconomic mineralization (Johnston 1968) as the host quartz veins are generally too narrow to be mineable. Best values indicated 3.62 percent molybdenum over 0.8 m (Assessment Files Research Office, Ontario Geological Survey, Toronto). Option on the property was shortly relinquished and no further work has been reported to date.

Geology. Mineralization is confined within an east-striking (trend N75E to N84W) quartz vein system emplaced within massive to sheared, fine-grained,

TABLE 4 ASSAYS OF GRAB SAMPLES FROM BAMAJI URANIUM OCCURRENCES, BAMAJI-FRY LAKES BELT.

Sample Number	Sample Description	U_3O_8	ThO_2	Au*	Ag*
Number One Showing					
HCG9-14A	well mineralized muscovite schist, disseminated pyrite (20-30 percent) carnotite staining abundant	0.10%	0.05%	0.20	Trace
HCG9-15	very similar to above but accompanied by black, sooty, fine grained masses	0.002%	0.05%	0.06	0.15
HCG9-17	pyritic sheared trondhjemite	N.D.	N.D.	0.40	0.16
HCG9-18	weakly foliated trondhjemite, stringers of pyrite	N.D.	N.D.	0.03	Trace
HCG9-19	weakly foliated trondhjemite with dark green actinolite veinlets, local pyrite veinlets	N.D.	N.D.	0.01	Trace
HCG9-20	carbonate-actinolite-biotite-chlorite fault breccia	N.D.	N.D.	0.01	Trace
HCG9-21	pyritic, sheared trondhjemite	N.D.	N.D.	0.01	Trace
Number Two Showing					
HCG9-22	Narrow actinolite biotite-pyrite veinlets in porphyritic biotite trondhjemite	0.04%	0.05%	0.04	—
HCG9-23	Leucocratic foliated pyritic biotite trondhjemite	0.06%	0.07%	0.02	—

N.D. — Not detected by emission spectroscopy.
* — In ounces per ton.
Assays by Geoscience Laboratories, Ontario Geological Survey.

TABLE 5 ASSAYS OF GRAB SAMPLES FROM THE LOON MOLYBDENITE PROSPECT, BAMAJI—FRY LAKES BELT.

Sample Number	Mineralization	Mo	Cu	Au*	Ag*	Pb	Zn	Bi
CG8-1	molybdenite in quartz vein	1.50%	N.D.	0.18	Trace	–	–	Trace
CG8-2	chalcopyrite-pyrite masses, 60 per cent sulphide	0.06%	2.91%	0.09	9.49	N.D.	N.D.	0.48%
CG8-3	pyrite+chalcopyrite in quartz vein	0.05%	0.45%	0.02	0.94	Trace	–	Trace
CG7-3	molybdenite in quartz vein	3.28%	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

* = in ounces per ton
N.D. = not determined
Assays by Geoscience Laboratories, Ontario Geological Survey.

recrystallized, light-grey leucocratic, homogeneous, biotite trondhjemite. Locally massive porphyritic (seriate) textures are subtly present as white plagioclase phenocrysts ranging up to 3 mm in length. The major mineralized quartz vein tends to pinch and swell over an exposed length of 12 m, reaching a maximum width of 1 m. Adjacent to the quartz veins highly schistose trondhjemite rich in sericite alteration is generally conspicuous for distances up to 30 cm.

Mineralization. Mineralization consists principally of fine to very fine-grained molybdenite occurring as narrow seams, clots, and disseminated flakes within commonly rusty grey to light blue grey sacharroidal quartz veins. Patches and veinlets of (up to 1.5 mm diameter) fine-grained to coarse-grained lime-green sericitic alteration often occur contiguous to the molybdenite. Generally, the mineralization comprises about 5 percent of the quartz vein. Disseminated to local patches of pyrite and chalcopyrite are invariably present. Ferrimolybdite staining is prevalent. Four grab samples taken by the writer returned molybdenum values varying between 0.05 percent and 3.28 percent Mo (Table 5), and copper values of 0.45 and 2.91 percent (assays by Geoscience Laboratories, Ontario Geological Survey, Toronto). The pyrite-chalcopyrite rich masses revealed significant silver values and traces of lead and bismuth.

Sanderson Ag-Au-Cu-Zn-Pb Prospect

The Sanderson silver-gold-copper-zinc-lead prospect is located approximately 5 km northeast of Slate Falls. Access is gained by foot-path leading from a north-trending narrow bay of North Bamaji Lake, situated about 3 km

east of Slate Falls. The property was investigated in 1966 by Cochenour Willans Gold Mines Limited. Development work involved stripping, trenching, and diamond drilling (nine holes totalling 450.5 m). Most of the drilling focussed on claim PA35897.

Geology and Structure. Bedrock close to the showings consists of grey-green (fresh surface) fine- to medium-grained, massive to foliated mafic metavolcanics cut by irregular dikes of fine-grained porphyritic (seriate) biotite quartz diorite of variable strike and width. Plagioclase phenocrysts within the dikes reach a maximum length of 3 mm. One trench exposed a porphyritic mafic flow composed of 3 to 5 percent rounded, buff-coloured phenocrysts of altered plagioclase up to 2 cm in maximum diameter.

Mineralization. Mineralization occurs within irregular, lensoid, possibly boudinaged milky quartz veins and stringers filling shear zones which cut the mafic metavolcanics. These shear zones generally trend east and dip vertically. Vein widths vary from 2 to 75 cm although generally less than 15 cm.

Commonly the quartz is milky white, fine-grained, and sacchroidal in texture. In order of decreasing abundance the sulphide minerals observed in the grab samples were pyrite, medium-brown sphalerite, tetrahedrite, chalcopyrite, pyrrhotite and galena. These sulphides occur as disseminations and as local masses in the vein quartz and often in more spectacular concentrations along slip planes which pass from the foliated mafic metavolcanics of the shear zones into quartz veins. Visible gold has been identified in diamond drill core (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Widespread azurite, limonitic, and minor malachite staining are common along these slip planes and fracture surfaces within the quartz veins. X-ray diffraction confirmed the presence of tetrahedrite. No chalcocite was found to be present. Total sulphide content generally does not exceed 5 percent of the quartz vein. Two grab samples of representative vein mineralization exposed within the trenches were taken by the author and analyzed (Table 6) by the Geoscience Laboratories, Ontario Geological Survey, Toronto.

Intensive drilling in 1966 by Cochenour Willans Gold Mines Limited on claim PA35897 followed the east-trending mineralized quartz vein shear system for approximately 270 m with eight holes probing the structure across strike at angles between 40 and 45 degrees (Assessment Files Research Office, Ontario Geological Survey, Toronto). Best intersections are listed in Table 7.

Significant silver and gold values were confirmed both by surface grab sampling of the present survey and by diamond drill intersections as tabulated above. However, the mineralization appears to be irregularly distributed and confined to relatively narrow widths. Cochenour Willans Gold Mines Limited dropped their interest in this property.

TABLE 6 | ASSAYS OF GRAB SAMPLES FROM SANDERSON AG-AU-CU-ZN-PB PROSPECT, BAMAJI-FRY LAKES BELT.

Sample Number	Silver*	Gold*	Copper	Lead	Zinc	Antimony	Bismuth	Molybdenum
CG7-1	3.70	0.04	0.27%	Trace	N.D.	0.09%	Trace	0.05-5.0%
CG7-2	34.41	0.47	1.49%	0.82%	0.1%	0.125%	Trace	Trace

* ounces per ton
Trace = 0.01 to 0.10 percent as determined by emission spectroscopy.
In sample CG7-2, .01 percent niobium was detected.
Samples collected by R. Sage, assays by Geoscience Laboratories, Ontario Geological Survey.

TABLE 7 | ASSAYS OF DRILL CORE FROM SANDERSON AG-AU-CU-ZN-PB PROSPECT, BAMAJI-FRY LAKES BELT.

Diamond Drill Hole	Assays in oz./ton*
BS66-1	1.38 Ag, 0.08 Au over 0.4 feet
BS66-3	0.36 Ag, over 1.6 feet
BS66-6	1.54 Ag, 0.04 Au over 2.0 feet
BS66-8	2.96 Ag, 0.20 Au over 1.5 feet
BS66-10	0.46 Ag over 0.6 feet
BS66-11	25.12 Ag, 6.24 Au over 0.7 feet

*Assays by Cochenour Willans Gold Mines Limited.

RECOMMENDATIONS FOR FUTURE EXPLORATION

More intense geological and geochemical study is warranted to outline more definitively the full extent of the molybdenum-bearing Bamaji Lake complex, particularly in the cursorily examined area between Senior, North Bamaji, and Snelgrove Lakes. The relatively low abundances of U_3O_8 (maximum 0.10 percent) and ThO_2 (maximum 0.07 percent), coupled with the narrow, sporadic, and fine-grained nature of the mineralization would seemingly render the two radioactive showings described above as of low economic interest at this time. The presence of significant gold values, however, may warrant a closer examination of the various shear zones within the immediate area of these showings.

JOHNSTON BAY-FRY LAKE BELT

The Johnston Bay-Fry Lake metavolcanic-metasedimentary belt (Figure 10, Chart A, back pocket) is the "greenstone" belt segment connecting the Lake St. Joseph belt with the Bamaji-Fry Lakes belt. It extends 24 km from just north of McVean Lake to Johnston Bay of Lake St. Joseph at the south boundary of the map-area, and has a maximum width of 13 km. Outcrop density of this belt is poor, ranging between 0.5 and 1 percent. The greatest exposure of bedrock is in the northeastern portion, in the McVean-Honderich Lakes area. Access to this area is by float plane to a few of the lakes large enough for landing. Otherwise access is restricted to transportation by means of helicopter. The previous work in the area includes a report with accompanying map by W.D. Harding (1936). The area was included within a regional mapping program carried out by the Geological Survey of Canada (Emslie 1960).

The geology of the metavolcanic-metasedimentary belt section between Lake St. Joseph and the Fry Lake-Jacknife Lake area is only partly understood. Extensive overburden, particularly west and south of Honderich Lake, inhibits the definition of the stratigraphy and geographic extent of the belt. The metavolcanics are predominantly of mafic to intermediate composition. Two relatively small felsic units are present. Mafic intrusive rocks are common at various locations throughout this belt, but generally do not form discrete mappable bodies. A metasedimentary unit which occurs along the margin of the belt northwest of Honderich Lake was roughly delineated. It may be continuous with the narrow metasedimentary unit which extends along the length of Bamaji Lake and also borders the Bamaji-Blackstone batholith to the south. The belt is located between two major granitic batholiths and its form and structure have been significantly affected by the emplacement of these bodies.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The mafic to intermediate metavolcanics of this belt weather dark to light greenish grey with fresh surfaces of dark greenish grey. These rocks are foliated to massive with pillowed types noted in the east-central portion of the area south of McVean Lake. Commonly, the metavolcanics are aphanitic to fine-grained, but some are nearly medium-grained, particularly in the pillowed outcrops. Mineralogically, hornblende and plagioclase are the dominant constituents with chlorite being common within the central portion of the belt.

Pillow structures vary in development from poorly defined to well preserved. The shapes of these pillows are elongated and not generally conducive to reliable top determinations. Only two top determinations were made, both suggesting tops to the south. The persistent occurrence of pillowed metavolcanics along a northwest-southeast line about 3.2 km south of McVean Lake may indicate that the regional stratigraphy in this area trends southeastward, and

generally parallel to the schistosity. Similar bedding-schistosity trends occur in metasediments approximately 3.2 km east of McVean Lake.

FELSIC TO INTERMEDIATE METAVOLCANICS

Mapping by Chatsko (1970) has delineated a southeast-trending unit of felsic metavolcanic tuff, agglomerate, and breccia approximately 2.8 km northeast of Drum Lake. This felsic metavolcanic unit is approximately 6.4 km long and reaches a maximum width of 0.4 km. The unit is divided nearly equally into an east and a west portion by a gabbro body approximately 3.2 km east of Drum Lake. The felsic metavolcanics and gabbro were not examined by members of this party.

On Johnston Bay, Lake St. Joseph, Clifford (1969) delineated a north trending unit of felsic metavolcanic tuff, agglomerate, and breccia intercalated with minor mafic metavolcanic rocks. To the north of Johnston Bay, scattered outcrops of felsic metavolcanics have been indicated by Chatsko (1970). The data suggests a felsic metavolcanic unit trending approximately north and pinching out near Drum Creek. Along the shore of Johnston Bay where some good exposures of this unit are present a width of approximately 0.8 km is indicated. Excluding some exposures in the Johnston Bay area, this unit was not examined by members of this party and the reader is referred to Clifford (1969) for a more detailed account of this unit.

METASEDIMENTS

Apart from minor intercalations within the mafic metavolcanics, the metasediments are concentrated in a major unit between Drum Lake and Honderich Lake. Metasediments in this zone are typically banded greywacke and arkosic to feldspathic arenite of very fine to fine grain size. Now metamorphosed to their schistose and gneissic equivalents, they are composed of several different mineral assemblages including hornblende-quartz-feldspar, muscovite-biotite-feldspar-quartz, biotite-feldspar-quartz, and muscovite-garnet-biotite-feldspar-quartz. In some assemblages feldspars comprise a very minor percentage of the mode. Banding of the metasediments shows a wide range of thickness but commonly varies from 0.5 to 12 cm.

Hornblende and feldspar-rich metasediments, presumably derived from the volcanic terrain, are present but metasediments possibly of granitic provenance are also in evidence. Examples of the latter are found in the section of the metasedimentary unit southeast of Drum Lake. At this location the typical metasediment is arkosic to feldspathic sandstone. The grains are very fine sand size with individual layers displaying contrasts in grain size and in the relative proportion of mafic mineral component.

Similar thinly bedded (0.5 cm in thickness) arkosic to feldspathic metasediments are found midway between Drum Lake and Honderich Lake. In thin section the coarser grained horizons have a visually estimated modal composition of 35 percent quartz, 35 percent feldspars (with microcline in slightly greater

amounts than plagioclase of andesine composition) and 20-25 percent hornblende. The felsic grains are subangular to angular polygonized and interlocked with the hornblende, which occurs as slightly larger euhedral to subhedral crystals. The presence of a significant amount of microcline suggests the possibility that the sediment was derived, at least in part, from a quartz monzonite to granodiorite or felsic volcanic source. A thin section prepared from an adjacent fine grained layer, displays a visually estimated mode of 80 percent subangular, polygonized quartz and feldspar and 15-20 percent subrounded, subspherical hornblende grains. The source of the grains is probably similar to that of the coarser layer.

MAFIC INTRUSIVE ROCKS

Coarse- to medium-grained, typically knobby weathering gabbro and diorite bodies appear much more commonly in this belt than in the Bamaji-Fry Lakes belt further north and west. The more prominent occurrences are found north of Honderich Lake, within both the metavolcanic and metasedimentary units on the east side of Drum Lake, 3.2 km east of McVean Lake, and within an area of prominent topographic relief approximately 6.4 km north of Honderich Lake.

The gabbro and diorite have dark green to dark greenish grey weathered surfaces with stubby actinolite crystals up to 6 mm in length weathering in relief. Fresh surfaces are light to dark greenish grey. The outcrops are normally massive with only locally developed foliations. Their intrusive nature is indicated by the inclusion of metasedimentary schist xenoliths within the body located on the east side of Drum Lake.

QUARTZ-FELDSPAR PORPHYRY

Within the belt, dikes of quartz and/or feldspar porphyry of undetermined extent were mapped north of Honderich Lake, 3.2 km north of Drum Lake, and along the Pickle Lake power line southeast of Fry Lake. The most prominent felsic intrusion appears as a linear unit southeast of Relyea Lake where several large outcrops of this body stand in relief above the surrounding terrain as massive, white, bald exposures (see Figure 10, Chart A, back pocket).

The weathered and fresh surfaces are usually a light whitish buff colour. The intrusions usually display rounded to angular quartz eyes and/or euhedral to subhedral andesine phenocrysts varying from less than 0.5 mm up to 4 mm in diameter within an aphanitic to fine grained groundmass. The groundmass is composed of very fine polygonized quartz and feldspar with aligned muscovite plates giving the rock a weakly developed schistosity. The proportion of phenocrysts to groundmass varies widely but they generally comprise no more than 10 percent of the rock. The relative amounts of quartz to andesine amongst the phenocrysts varies from dike to dike.

METAMORPHISM

The anorthite content of the plagioclase is consistently greater than 15 percent and this coupled with the general absence of chlorite indicates that the grade of metamorphism is at least lower amphibolite facies of regional metamorphism, The continuing presence of muscovite in the presence of quartz, such as within the felsic porphyry dikes, demonstrates that the prevailing grade of metamorphism did not reach upper amphibolite facies, that is the sillimanite-almandine-orthoclase subfacies.

Structural Geology

The foliations (schistosity) near the belt margins except in local areas tend to parallel the margins. South and west of McVean Lake, the foliations are generally easterly to southeasterly parallel to bedding and generally dip vertically or southward. Close to the east margin of the belt in the Honderich Lake area, the foliations with the metavolcanics swing around sharply to more closely parallel the contact of the greenstone belt with its enclosing wall rocks. It is unknown whether the bedding responds similarly, but the magnetic pattern of the iron formation suggests that it does.

The Drum Lake-Honderich Lake sedimentary unit displays, at individual outcrops, very complex folding; however, the general foliations parallel the bedding. Although the strikes are highly variable, the dips are consistently northward averaging approximately 50-60°. In contrast, the metavolcanics in the McVean Lake area dip southward, and with minor evidence from some pillow top determinations, it is suggested that a syncline may exist with a southeasterly trending fold axis located midway between McVean Lake and Honderich Lake. No indication of top orientation was noted in the metasedimentary unit to support this suggestion.

Economic Geology

Sulphide mineralization occurs in this poorly exposed metavolcanic belt as evidenced by diamond drill intersection (see Appendix B, Summary of Assessment Work), however, no economically interesting concentrations have been delineated to date. Sulphide masses (pyrrhotite-pyrite) have also been observed within pillow selvedges (L. Chatsko, personal communication 1972).

MEEN-DEMPSTER LAKES BELT

The limits of the Meen-Dempster Lakes belt were arbitrarily selected for mapping convenience (Figure 11, Chart B, back pocket). This belt merges with the Bamaji-Fry Lakes belt to the southwest, the Johnston Bay-Fry Lake belt to the south, and the Dempster-Pickle Lakes belt to the east. To the northwest the

belt is migmatized and aeromagnetic data (ODM-GSC 1960, Maps 893G and 903G) suggest the possibility of a former connection with the metavolcanics and metasediments of the Zionz Lake belt.

Outcrop exposure within the belt is quite variable. In the Meen Lake area outcrop is concentrated principally along waterways and lakes and comprises 1 or 2 percent of the surface area. In the Kaminiskag Lake area the outcrop density is 3 to 4 percent and can be found between the lakes and streams as well as along their banks. The area between Meen Lake and Kaminiskag Lake has only sparse outcrop, largely along lakeshores.

The rocks are dominantly mafic metavolcanics. Felsic metavolcanics are present which are in part pyroclastic and in part possibly of very shallow intrusive origin. Felsic metavolcanics are present in both the Meen Lake and Dempster Lake areas. Aeromagnetic data suggest the presence of iron formation in a number of areas and lean iron formation was observed in outcrop on the north shore of Jacknife Lake.

Metasediments are not common within the main part of the belt but are abundant in the margin of the belt adjoining the Bamaji-Fry Lakes belt. Limited outcrop data and diamond drill logs in the adjoining area submitted for assessment credit by Cochenour Willans Gold Mines Limited indicate that greywacke and argillite are the dominant sedimentary rock types. A cobble and boulder conglomerate on Billett Lake is particularly spectacular.

A periodotite body outcrops at the south end of a small lake along the stream channel between Kaminiskag and Jacknife Lakes.

Two granitic stocks intrude the metasedimentary-metavolcanic sequences. One small stock in centered on Kawashe Lake and is referred to as the Kawashe Lake stock and a second is centered over the south end of Graniteboss Lake and is referred to as the Graniteboss Lake stock.

For total rock chemistry of a select group of samples collected from this belt, the reader should refer to Appendix A (back pocket) of this report.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Massive to foliated mafic metavolcanics are by far the dominant rock type of the Meen-Dempster Lakes belt. Identifiable mafic tuffs and pyroclastics comprising very minor units were noted throughout the belt. Pillowed mafic metavolcanics (Photo 8) are not common but occur on Meen Lake and on the north side of Kaminiskag Lake. The pillow structures are generally deformed making stratigraphic top determinations difficult. On Meen Lake extensively pitted weathering surfaces on some outcrops may be due to the vesicular or fragmental character of the rocks. On the north side of Kaminiskag Lake one outcrop with possible flow banding was located.

The mafic metavolcanics within the central portion of the belt consist of predominantly chlorite schist, and massive fine-grained chlorite-actinolite rocks, indicative of greenschist facies metamorphic rank. The metamorphic

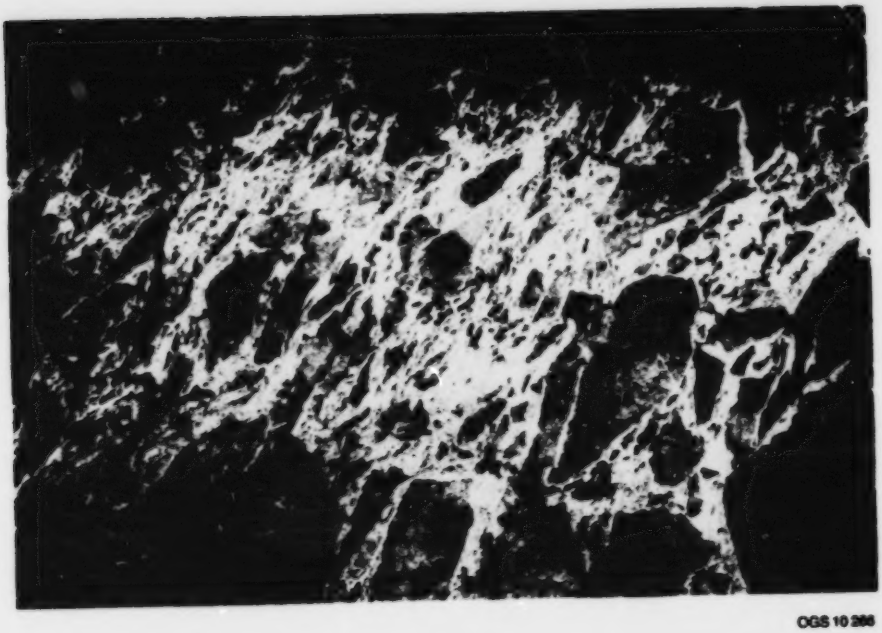
OGS 10 265

Photo 8–Pillowed mafic metavolcanics, southeast corner of Dorothy Lake, Meen-Dempster Lakes belt.

rank increases to middle amphibolite facies at the contact of the belt with the granitic batholithic complex. The mineralogy changes from chlorite-actinolite to hornblende-plagioclase with increasing metamorphic grade. A number of massive medium-grained mafic rocks (Photo 9) possibly representing thick flow centers or sill-like mafic intrusives were examined but due to lack of distinguishing criteria these were largely classified as mafic metavolcanics.

On weathered surfaces the mafic metavolcanics are grey-green, green, or grey-black. On fresh surfaces darker hues of the same colours are evident, with dark green being dominant. The darker colours are more typical of the rocks of higher metamorphic grade. In thin-section the greenschist rocks contain cloudy plagioclase, actinolite-tremolite, epidote-zoisite, minor quartz, and traces of opaques. With increasing metamorphic grade, the dominant rock type is composed of hornblende in amounts up to 50 percent in association with a mosaic of clear, untwinned fine-grained plagioclase. Trace amounts of magnetite are usually present in the higher grade rocks.

One banded amphibolite, at the northwestern extremity of the belt immediately east of Meen Lake, associated with the granitic intrusion of the area contained 5-10 percent epidote, 20-25 percent augite, and 40-50 percent plagioclase of calcic andesine composition. An outcrop of a highly sheared porphy-



OGS 10 286

Photo 9–Brecciated, massive, mafic metavolcanics intruded by diorite, outcrop along west shore of small lake approximately 1.6 km southeast of the extreme eastern end of Meen Lake, Meen-Dempster Lakes belt.

ritic intermediate to mafic metavolcanics was observed on a large unnamed lake on the stream channel leading north from Muskegsagagen Lake. Relict ophitic texture was noted in a thin-section of massive mafic metavolcanics of greenschist facies metamorphic rank collected from an outcrop on the west shore of Kaminiskag Lake.

FELSIC TO INTERMEDIATE METAVOLCANICS

Major felsic to intermediate metavolcanic centres in the Meen-Dempster Lakes belt are not well exposed. Both the Meen Lake area and Dempster Lake area contain minor felsic to intermediate metavolcanic units, generally less than 30 m in thickness, intercalated with mafic metavolcanics.

The felsic to intermediate metavolcanics in both areas appear to be very similar in both outcrop appearance and petrography. The area between Meen and Dempster Lakes has little outcrop and the felsic to intermediate metavolcanic units have been extended into this area based only on aeromagnetic data.

Cat Lake-Pickle Lake Area

The felsic to intermediate metavolcanics are typically porphyritic. Petrographically, no difference could be detected between units originally mapped in the field as felsic pyroclastics and those mapped as possible sill-like intrusions or flows. Both of these rock types contain euhedral grains in a fine-grained recrystallized groundmass, but those units mapped as tuff sometimes contain broken crystal fragments and domains of differing grain size and/or variations in mineralogy suggesting a former clastic nature. The rock types are most likely gradational into one another and have not been subdivided on Figure 11.

Meen Lake Area

In outcrop the felsic metavolcanics of the Meen Lake area form units generally less than 15 m and rarely about 30 m in width which are intercalated with foliated, massive and pillowed mafic to intermediate metavolcanics. The rocks are commonly porphyritic with phenocrysts of quartz and/or plagioclase. Well foliated quartz-sericite schist thought to represent former felsic tuff is present in several areas. Generally the phenocrysts within the porphyry units are no larger than 1 or 2 mm but some of the suspected sill rocks contain phenocrysts about 5 mm in size. On weathered surface the rocks weather white, and grey to dark grey. On fresh surface they are very pale green, light grey, and in some cases, even black. On a large irregular lake just southeast of Meen Lake outcrops of sheared and foliated tuff and lapilli-tuff to breccia with porphyritic fragments varying from 5 to 15 cm are located on the western portion of the lake.

In thin-section the felsic to intermediate metavolcanics are seen to be fine to medium grained, equigranular to inequigranular porphyritic, and hypidiomorphic. The more porphyritic rocks often display undulatory extinction of the quartz grains. Plagioclase phenocrysts are generally of andesine composition, display weak to moderate zoning and are altered in part to zoisite and sericite. In the sericite schists, sericite mica is the dominant mineral. In the porphyritic rocks, the total percentage of phenocrysts rarely exceeds 50 percent with quartz being generally considerably subordinate to plagioclase, and in some cases, absent entirely. The groundmass of the porphyritic rocks as well as the non-porphyritic felsic rocks is fine-grained and consists of a mosaic of quartz and untwinned plagioclase. Often variations in grain size and/or mafic content suggest that the rocks are of a fragmental nature. The mafic mineral commonly found in the groundmass is generally biotite, which occurs in amounts not exceeding 10 percent. One lapilli-tuff unit which contains felsic fragments in a more mafic groundmass has between 20 and 30 percent hornblende. Quartz, garnet, and chlorite occur in minor amounts as accessory minerals.

Dempster Lake Area

A series of felsic metavolcanic units of an aggregate thickness of approximately 1.2 km is exposed along the north shore of Dempster Lake. This unit is

interpreted to be correlative with similar rocks on the southeast end of Kawinogans Lake in the Dempster-Pickle Lakes belt.

The felsic to intermediate metavolcanics of Dempster Lake are interpreted to represent a sequence of tuff, lapilli-tuff, and sill-like intrusions. On weathered surface, the felsic to intermediate metavolcanics are pinkish to white and on fresh surface shades of pale pink and green are most common. The rocks are porphyritic and are generally well foliated.

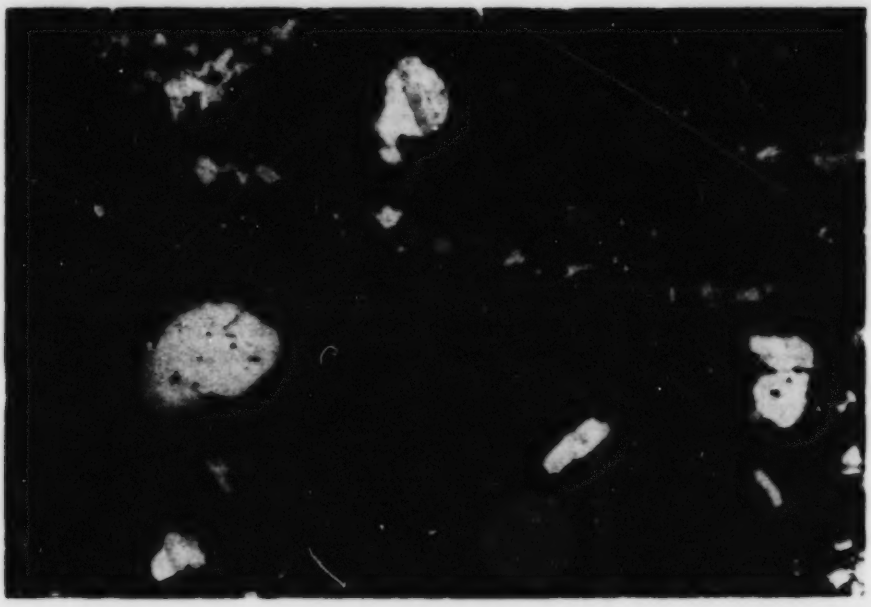
In thin section, the felsic to intermediate metavolcanics of Dempster Lake are visually estimated to contain 0-10 percent quartz phenocrysts, 10 to 25 percent plagioclase phenocrysts of andesine composition, 1-20 percent carbonate as veinlets and disseminated grains, and the bulk of the remainder is a mosaic of fine-grained quartz and untwinned plagioclase. Sericite 0-10 percent, zoisite 0-1 percent and chlorite up to 1 percent are common alteration products. Opaque minerals are present in trace amounts. All samples examined in thin section had a porphyritic texture. The euhedral outline of the phenocrysts of some rocks in combination with outcrop observations would indicate sill-like intrusions or coarse-grained pyroclastics. Other samples consisting of broken crystal fragments are interpreted as crystal tuffs.

A tuff-breccia outcrop on the southwest shore of Muskegsagagen Lake consists of light coloured felsic fragments averaging 5 to 8 cm in size in a chlorite schist matrix. This unit most likely is of intermediate volcanic bulk composition. It was not examined in thin section.

On the southwest corner of Kaminiskag Lake and roughly on strike with aeromagnetically inferred felsic to intermediate metavolcanics at Muskegsagagen Lake, are outcrops of thin (15 m) tuff and lapilli-tuff to breccia units intercalated with mafic to intermediate metavolcanics and metagabbro. In the coarser-grained pyroclastics, large 5 cm fragments are present in a chlorite schist matrix. The clasts are highly stretched and of uniform feldspar porphyry composition. Thin-sections prepared from felsic to intermediate fragmental rocks on Kaminiskag Lake indicate quartz as phenocrysts up to a visually estimated 15 percent, plagioclase phenocrysts, of oligoclase and andesine composition, in amounts up to 30 percent, and a fine grained groundmass consisting of a mosaic of quartz and untwinned plagioclase. The quartz phenocrysts commonly show wavy extinction and the plagioclase is commonly altered to zoisite and sericite. Sericite often forms a significant proportion of the rock. In some rocks, domains of varying grain size and/or composition suggest a pyroclastic origin. Minor amounts of chlorite, biotite, and magnetite were noted.

Felsic to intermediate metavolcanics are also present along a small lake located on the stream channel between Kaminiskag and Jacknife Lakes. Here, the felsic to intermediate metavolcanics are a light grey-green on weathered surface and grey-green on fresh surface. The rock displays a well developed foliation and phenocrysts of quartz and plagioclase are visible to the unaided eye.

The rock between Kaminiskag and Jacknife Lakes, in thin section (Photo 10), is visually estimated to contain 5 to 10 percent quartz phenocrysts and 30 to 40 percent plagioclase phenocrysts of oligoclase to andesine composition set in a mosaic groundmass of fine grained quartz and untwinned plagioclase. The bulk of the remainder of the rock is composed of chlorite 10-15 percent, carbonate 5 to 8 percent, and zoisite 10-15 percent. A trace of biotite was noted. The quartz phenocrysts display a weak undulatory extinction and the broken and fragmented nature of the crystals is suggestive that the rock is a crystal tuff.



OGS 10 287

Photo 10–Photomicrograph of crystal tuff containing fractured quartz grains and angular clasts of plagioclase. Sample collected from unnamed lake south of Kaminiskag Lake, and north of Jackfish Lake, Meen-Dempster Lakes belt.

Minor occurrences of felsic to intermediate metavolcanics are located 3.2 km north of Teevin Lake on and adjacent to the Pickle Lake power line. These metavolcanics are aphanitic with whitish-buff fresh and weathered surfaces, have only a vague foliation and comprise units ranging from 1 to 1.8 m in width, interlayered with mafic to intermediate metavolcanics.

The only significant petrographic difference between the rocks of the Dempster Lake and Meen Lake areas is the presence of notable quantities of carbonate as tiny veinlets and disseminated grains in Dempster Lake rocks. The carbonate appears to be secondary but its apparent widespread distribution would suggest that it is probably related to the volcanic processes operating at the time of emplacement of the felsic metavolcanic rocks. From petrographic observation, rocks mapped as possible sills or flows could not be distinguished from those mapped as coarse pyroclastics. Those rocks mapped as tuff, lapilli-tuff, and crystal tuff could be easily distinguished from the flow/sill or coarse pyroclastic rocks. The tuff contains broken crystal fragments and/or domains of varying grain size and/or composition, interpreted to be representative of a former clastic nature.

OGS 10 288

Photo 11–Boulder and cobble conglomerate, Billett Lake, Meen-Dempster Lakes belt.

METASEDIMENTS

Within the Meen-Dempster Lakes belt relatively little sedimentary rock was observed in outcrop. The area which appears to be dominantly metasediments occurs within the area of little outcrop between the Meen-Dempster Lakes belt and the Bamaji-Fry Lakes belt.

Diamond drill logs submitted for assessment work credit by Cochenour Willans Gold Mines Limited on holes drilled north and southeast of Billet Lake indicate tuffaceous greywacke and argillite as nearly the only rock types. Mafic to intermediate metavolcanics of various types and minor felsic to intermediate metavolcanics occur associated with these metasediments. On the southeast side of Relyea Lake an outcrop of feldspathic greywacke occurs. In weathered outcrop the rock is grey brown and on fresh surface light brown. The rock has a mosaic texture with some grains being significantly larger, by a factor of 2 or 3, than those that comprise the bulk of the rock (average grain size 1-2 mm). Of particular note is the spectacular exposure of a cobble-boulder conglomerate (Photo 11) on the south shore of Billet Lake. The presence of this lithologic unit had been noted in earlier mapping by the Ontario Department of Mines (Harding 1936).

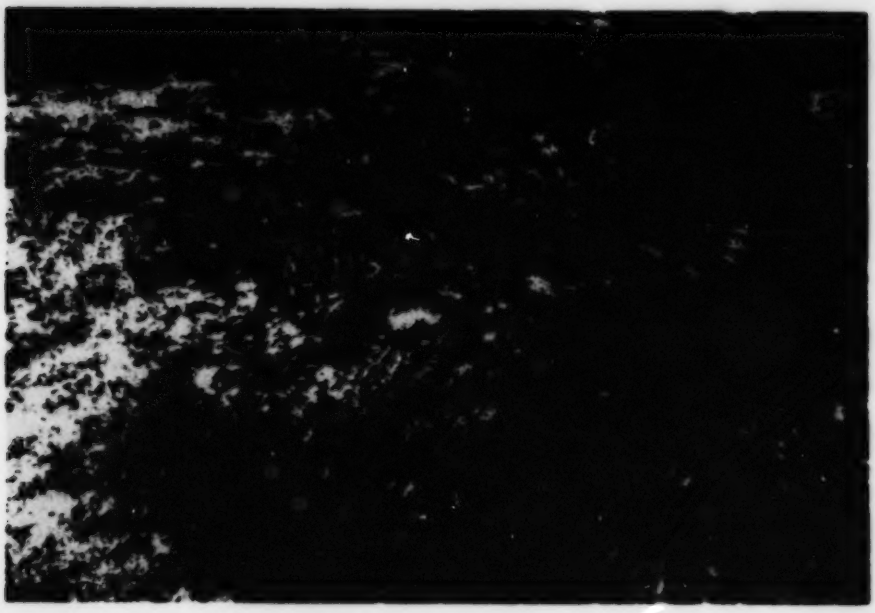
Graded bedding in greywacke on the shore at the southeast end of Billet Lake indicates stratigraphic tops to the north. Bedding, consisting of alternating conglomerate and greywacke layers strikes N80E and dips vertically. The bedding is penetrated by a well developed schistosity striking N65W and dipping vertically. The stratigraphic-structural relations indicate the presence of an anticlinal axis to the south and such a structure was mapped to the immediate south in the Bamaji-Fry Lakes belt. Pebble elongation in the plane of schistosity plunges 45-60 degrees to the southeast, with the smaller pebbles and cobbles showing a greater degree of elongation than the larger clasts. Local disruption of the bedding is thought to represent a slumpage of the sediments before consolidation. The conglomerate is polymictic, with the interstices of the intact framework being filled with biotite-quartz-feldspar schist.

A large pebble- and cobble-bearing sample containing several varieties of clasts was collected and given to R.T. Bell of Brock University. Slabs of the specimen were prepared and a petrographic examination was made of several clasts by his student G. Funk. The following petrographic description is condensed from notes prepared by Funk.

Slabbing and staining disclosed seven clasts of leucocratic granitic rock, two of coarse-grained amphibolite, four of fine-grained amphibolite, and one of feldspar porphyry. The amphibolitic clasts were not examined petrographically but are assumed to have been derived from mafic volcanic rocks. The feldspar porphyry contains 2-3 mm phenocrysts of feldspar and quartz (approximately 20 percent, with feldspar greatly dominant) in a homogeneous to brecciated aphanitic to finely recrystallized groundmass. The porphyry could represent either a felsic extrusive or shallow intrusive rock. The leucocratic granitic clasts, one with a well developed gneissosity, all displayed varying degrees of cataclastic and recrystallization textures upon petrographic examination. The granitic clasts are trondhjemitic in composition with sodic to calcic oligoclase feldspar. One sample may have originally been porphyritic but cataclasis obscures positive identification. The feldspar phenocrysts are set in a mosaic groundmass of recrystallized fine- to medium-grained quartz and plagioclase. Mafic content of the granitic clasts is low (generally less than 5 percent) and one brecciated sample has a hypidiomorphic texture with fragments enclosed within cataclastic material. The gneissic fragment, in which banding is the result of both compositional and grain size variation, is possibly porphyritic. Some layers have well developed granitoid textures while others appear to be thin mylonite zones. The borders of the gneissic clast are also granulated.

All specimens were stained for K-feldspar with negative results. The cataclastic textures described by Bell and his student appear similar to those observed in thin section by the author in samples collected along the north flank of the Meen-Dempster Lakes belt. The presence of cobbles with cataclastic textures in metasediments within the belt suggests that faults bounding the "greenstone" belt were active at the time of the Early Precambrian volcanism and sedimentation and that the cobbles may have been derived from fault scarps marginal to the basins.

Bell described the matrix of the conglomerate as having up to 10 percent angular quartz of approximately 8 mm grain size. The quartz is polycrystalline and feldspar clasts are also present. The remaining 90 percent of the matrix is described as fine- to medium-grained calcite-biotite-quartz-plagioclase schist.



OGS 10 289

Photo 12–Folded banded cherty iron formation, north shore of Jacknife Lake, Meen-Dempster Lakes belt. Outcrops west of this exposure are rich in carbonate and possibly a lateral facies of this unit.

Fine grained plagioclase-quartz aggregates observed in the matrix may represent fragments of pyroclastic rocks. A few fine aggregates of muscovite were identified, and zircon, sphene and leucoxene occur as accessory minerals.

An arkosic cherty limestone on the west end of Jacknife Lake probably represents a facies of the iron formation occurring on Jacknife Lake and described below.

IRON FORMATION

Throughout the Meen Lake-Dempster Lake area several occurrences of lean iron formation were noted. Almost always, there is little indication of these occurrences on 1 inch to 1 mile aeromagnetic maps of the area and they were thus interpreted to be of limited extent. Aeromagnetic data for the area (Maps 903G and 913G, ODM-GSC 1960; File 2.687, Assessment Files Research Office, Ontario Geological Survey, Toronto) indicate a number of linear magnetic highs interpreted to be iron formation which were not observed in outcrop.

One particularly notable showing of lean (iron deficient) iron formation occurs on the north shore of Jacknife Lake. This unit consists of a thinly banded chert-greywacke unit of about 60 m thickness. The unit is complexly folded (Photo 12) which may in part be due to slumpage before complete consolidation. The individual chert layers are approximately 2.5 cm in width and consist of very fine laminae (1 mm) of chert. The greywacke bands are of similar width and are represented by a biotite-quartz-feldspar schist. The chert bands weather grey to grey-black; on fresh surface they are dark grey to black. The greywacke layers are brown on weathered surface and dark brown on fresh surface. The weathered surface is often pitted due to preferential erosion of carbonate which is commonly present. One thin section was prepared from the greywacke bands and this was visually estimated to consist of 25-35 percent angular quartz grains with wavy extinction, 40-50 percent lithic fragments, and 30-75 percent fine-grained matrix, consisting of very fine grained chert and carbonate. The lithic fragments comprise chert and possibly felsic to intermediate metavolcanics. Trace amounts of chlorite are present. The greywacke bands are classified as lithic greywacke.

On the west end of Jacknife Lake a rock unit, initially thought to be volcanic tuff, upon thin-section examination, appears to be a lateral facies equivalent of the greywacke-chert iron formation. On weathered surface the rock is grey and has a porous texture similar to a very fine grained coquina. On fresh surface the rock is a grey green colour. In thin section the rock consists of 10-15 percent angular quartz grains, 5 percent angular cloudy plagioclase grains, 50-60 percent carbonate, and 30-35 percent fine-grained matrix (mostly chert). Trace amounts of chlorite are present. The carbonate is thought to be calcite because of the lack of rusty stains on the weathered surface typical of ankerite or siderite, and the lack of euhedral crystals typical of dolomite. The carbonate is an essential part of the fabric of the rock and is considered to be a primary feature and not a secondary alteration. The rock is tentatively classed as an arkosic cherty limestone.

MAFIC INTRUSIVE ROCKS

Mafic intrusive rocks are thought to be abundant in the Meen-Dempster Lakes belt, but the separation of these units from mafic flow rocks was generally not possible. Coarse-grained, massive units although possibly sill-like intrusions have largely been grouped with the mafic metavolcanics.

On the southeast shore of Dorothy Lake an outcrop of massive coarse-grained gabbroic anorthosite was located which cut mafic metavolcanics and in turn was brecciated and cut by pink to red medium-grained equigranular granitic rock. The gabbroic anorthosite rock was not examined in thin section. From aeromagnetic data a small mafic stock of approximately 1.6 km^2 in surface area is interpreted to be present on the southeast corner of Dorothy Lake (Map 903G, ODM-GSC 1960).

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Photo 13–Photomicrograph (10X, plane light) of chloritized peridotite. Sample collected from outcrop at the southern extremity of a small lake located on the drainage system between Jacknife Lake and Kaminiskag Lake, Meen-Dempster Lakes belt.

ULTRAMAFIC INTRUSIVE ROCKS

An outcrop of peridotite is located at the southern extremity of a small lake on the drainage system between Jacknife Lake and Kaminiskag Lake. On weathered surface the rock displays a weak to moderately developed sieve-like texture suggesting the presence of olivine grains about 1 mm in diameter. The rock weathers dark brownish green and is not noticeably different from the enclosing mafic metavolcanics. On fresh surface the rock has a blue green hue which is quite distinct from the surrounding mafic metavolcanics. It is soft, fine grained, and composed mostly of chlorite.

In thin section the rock is composed of 70 percent or more chloritized olivine, 15-20 percent chloritized pyroxene, and about 10 percent magnetite. In thin section (Photo 13) the form of the original olivine grains is easily discernible even though the grains are completely pseudomorphed by chlorite. The chlorite is fibrous and radiates inwards towards the center of the former olivine

grain or forms a composite patch work of parallel fibres in differing orientations. Under crossed nicols it has a striking blue-green interference colour and displays parallel extinction. The chlorite after olivine is tentatively classified as penninite. Minor amounts of penninite also occur interstitially. Interstitial to the former olivine grains is a second chlorite mineral which is postulated to be an alteration of former pyroxene even though all crystal morphology of pyroxene has been obliterated in the process of alteration to chlorite. The mineral is colourless to pleochroic in brown to green, has a small 2V, is optically positive, and length fast, has moderate relief, weak birefringence and Z/\c 70-84 degrees. The optical data fits closely that of chloritoid. The magnetite occurs interstitially and in plain polarized light the fine grained opaques readily outline the boundaries of the former olivine grains. The pseudomorphed olivine grains locally form a very close packed framework with little if any interstitial mineral. From aeromagnetic data the authors believe that this small ultramafic plug covers an area of approximately 2.1 km^2 and is elongated in an east-west direction parallel to the enclosing metavolcanics.

On a small lake just southeast of Dempster Lake, a small 8 cm wide dike cuts mafic metavolcanics. The rock is dark green to black on weathered surface and has a darker hue on fresh surface. The rock in hand sample has a well developed foliation marked by plates of chlorite in a fine grained aphanitic groundmass. In thin section the rock is visually estimated to contain 50-70 percent actinolite, 10-15 percent carbonate, 10 percent chlorite, and 10-15 percent very fine grained quartz. The quartz is interstitial and considered to be an alteration product. This small dike appears to have mafic to ultramafic affinities.

MIGMATITE

See "Structural Geology".

QUARTZ-FELDSPAR PORPHYRY

Petrographic examination of felsic to intermediate rocks mapped as metavolcanics in the Meen Lake and Dempster Lake areas suggested that some of these units could be very shallow intrusions. However, due to the lack of diagnostic criteria those rocks have been included with the felsic metavolcanics.

In the vicinity of Relyea Lake a felsic unit approximately 1.3 km^2 in surface area is thought to be representative of a very shallow intrusion. From scattered outcrop data the body is inferred to be elongated (ratio 9:1) in a northwest-southeast direction and is conformable with the enclosing metasediments and metavolcanics. The elongate, conformable nature suggests that the body may be a sill. The unit is particularly well exposed as a large white outcrop which can easily be seen from the air.

In outcrop, the rock on weathered surface is grey-white, porphyritic, and massive. On fresh surface the rock is a light brown. The phenocrysts consist predominantly of quartz (2 mm in diameter) in a fine grained sericitic groundmass. The massive unit has a local schistosity which is conformable with the

regional trend of foliation. Minor, barren, blue-grey quartz veins, 2.5 to 7.5 mm wide were observed to cut the unit. Traces of pyrite and elongated acicular amphibole crystals up to 1 cm in length were noted on some schistosity surfaces. In thin section the rock is visually estimated to contain 15-20 percent sericite, 1 percent oblate quartz phenocrysts, 10 percent fractured plagioclase phenocrysts of andesine composition, 1-2 percent biotite, and 60-70 percent fine-grained groundmass mosaic of quartz and untwinned plagioclase. The quartz displays a wavy extinction. The fractured plagioclase grains often have separated into individual fragments but commonly they can be seen to have matching boundaries. The lack of a fragmental appearance in outcrop or a positive identifiable fragmental nature in thin section, and its microscopic texture suggest that the body is a very shallow sill-like intrusion.

Whole rock analysis indicates that the rock is equivalent to a sodic rhyolite. The reader is referred to sample HCF 13-9 in Appendix A (back pocket) of this report for the whole rock, normative, and trace element data.

Structural Geology

From limited and often subjective pillow top data and very limited occurrences of graded bedding the Meen-Dempster Lakes belt is interpreted to be an isoclinally folded syncline (Map 2218, back pocket). The synclinal structure may be slightly overturned to the south.

Foliations were observed to almost exclusively parallel the bedding and upon applying this observation, broad open folds are interpreted to exist along the margins of the belt. This folding is thought to be in part related to the emplacement and tectonic adjustment caused by the intrusion of the granitic plutons marginal to the belt.

In the vicinity of Kaminiskag, Kawashe, and Jacknife Lakes, considerable variation in the strike of the foliations would suggest structural complexities in this area. These complexities possibly relate to the emplacement of the Kawashe Lake and Graniteboss Lake granitic stocks. The much larger Graniteboss Lake stock, the long axis of which is normal to the synclinal axis of the Meen-Dempster Lakes belt, would undoubtedly be the dominating influence.

To the northwest and to some extent in the Dorothy Lake area the southern contact of the belt is injected by various massive granitic rock types and granite pegmatite. The southern contact is migmatized, displays raft structures (metamorphosed volcanic blocks in a granitic matrix), and ptygmatic injections of granitic material. The southern contact is distinctly intrusive in character.

The north contact of the belt displays complex characteristics of intrusion and cataclasis. The granitic rock types along the north contact, and particularly on the large lake north of Muskegsagagen Lake, show a wide variation in composition, appear to interdigitate to some degree with the metavolcanics, and have a pronounced foliation and gneissosity. Thin section examination of granitic rocks from along this contact reveals abundant evidence of cataclasis and recrystallization. The quartz grains have a pronounced wavy extinction and are fractured. The plagioclase grains are bent and broken. Euhedral grains are absent and a recrystallized mosaic of interlocking grain boundaries is ubi-

OGS 10 271

Photo 14–Photomicrograph (10X, crossed nicols) of mylonite. Sample collected from shore of small lake approximately 1.6 km southeast of the east end of Meen Lake, Meen-Dempster Lakes belt.

quitous. Much secondary zoisite, sericite, and chlorite alteration is present. Concentrations of more mafic minerals into bands (Photo 14) enhance the banded nature of the rock and in thin section this banding, in part, appears to bend around porphyroclasts which may have undergone some rotation.

The rocks on the north margin of the Meen-Dempster Lakes belt separating the metavolcanics from the main granitic terrain to the north closely resemble protomylonites (Higgins 1971, p.3,7,14). Thus a complex interplay of magmatism and tectonism along the northern margin of the belt seems to have occurred.

From sketchy outcrop data, airphoto interpretation, and aeromagnetic trends the area between the Meen-Dempster Lakes belt and the Lang Lake belt is thought to be structurally complex. This area is thought to represent an interdigitating sequence of metavolcanic and granitic rocks of various types which have been modified by tectonism. Data is lacking to prove or disprove any primary relationship between the Lang Lake and Meen-Dempster Lakes belts, thus, at present, any correlations between these two belts must remain speculative.

Economic Geology

Only meager mineral exploration has been recorded in the Meen-Dempster Lakes belt to date. Early prospecting most likely was concerned with a search for gold mineralization. In 1962, Jorsco Explorations Limited investigated a block of 36 claims (File 63.1157, Assessment Files Research Office, Ontario Geological Survey, Toronto) in the Meen Lake area. Ground electromagnetic, magnetic, and geological surveys delineated four units of lean banded iron formation within mafic metavolcanics. These iron formations are commonly mineralized with fractures and stockworks of pyrite. Best recorded assay disclosed only 0.02 ounces gold per ton from a quartz vein on claim KRL49049 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1963, New Jersey Zinc Exploration Company Limited examined gold-silver occurrences 3.2 km north of Muskegsagagen Lake by trenching and diamond drilling (six holes totalling 216 m). Results were generally disappointing. Best assays from diamond drill core registered 0.32 ounces gold per ton over 0.27 m in pyritic quartz vein and 0.12 ounces silver per ton across 0.58 m in quartz-feldspar porphyry (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1971-1972 the Union Miniere Explorations and Mining Corporation Limited (UMEX) investigated the mineral potential of this belt. In 1973, the company completed combined INPUT electromagnetic and magnetic airborne surveys of the belt between Dorothy Lake and Gitchie Lake (E. Reeve, UMEX, personal communication). This survey was in part instigated by a previously unknown westward extension of the Meen-Dempster Lakes belt as disclosed by mapping of the present survey. Extensive ground geophysical surveys, diamond drilling, and geological mapping had been completed at the time of writing by UMEX in the Kawashe Lake area (E. Reeve, personal communication).

Twelve grab samples containing pyrite and/or pyrrhotite sulphide mineralization, quartz veins, and magnetite iron formation associated with mafic to intermediate metavolcanics were submitted for analysis to the Geoscience Laboratories, Ontario Geological Survey. Trace amounts of silver and trace to 0.02 ounces of gold per ton were recorded on 10 samples and nil amounts of those metals registered on the remainder. Analysis of a grab sample from a small peridotite intrusion immediately north of Jacknife Lake indicated 0.15 percent copper and 0.15 percent nickel. A UMEX analysis indicated 0.14 percent nickel and 0.04 percent copper (E. Reeve, personal communication). Emission spectroscopy indicated no appreciable concentrations of any other economically important metals in any of the 10 samples submitted for analysis. A grab sample of the Jacknife Lake chert-magnetite iron formation by UMEX disclosed 0.02 ounces gold per ton (E. Reeve, personal communication).

RECOMMENDATIONS FOR FUTURE EXPLORATION

Attention should be directed to an extensive narrow horizon of felsic metavolcanics interpreted to trend from Muskegsagagen Lake to northwest beyond Dorothy Lake. Detailed mapping is required to verify its actual extent and po-

sition within the volcanic pile and possible presence of economically important coarse pyroclastic volcanic centers. Very little geological investigation has been done in the area between Meen Lake and Gitchie Lake.

DEMPSTER-PICKLE LAKES BELT

South of the Ochig Lake Pluton the Dempster-Pickle Lakes belt merges to the east with the Osnaburgh-Pickle Lakes belt. To the west it merges with the Meen-Dempster Lakes belt. In its eastern extent, the belt consists of two east-trending metavolcanic units which are separated by an elongate granitic mass. These two units are of variable width but generally average 3 km. Trending in a southwesterly direction from the southern margin of the most southerly located east-trending unit are three metasedimentary units of predominantly greywacke composition. The metasediments were probably derived from a predominantly volcanic terrain. One possible porphyritic intrusion and one minor unit of felsic metavolcanics were delineated.

Outcrop density within this belt is low to non-existent precluding an accurate geological interpretation. Locations of the margins of the belt are based on aeromagnetic data (Maps 912G, 913G, 922G, and 923G, ODM-GSC 1960).

Outcrops that do exist occur along the margins of lakes and along stream banks. Mapping consisted of lake shore and stream channel traverses with land traversing into outcrop areas previously delineated by helicopter surveying. Access to the area is by float-equipped aircraft.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The dominant rock type in the Dempster-Pickle Lakes belt is mafic to intermediate metavolcanics. The rocks display a well developed foliation and relatively few primary structures. Deformed pillow structures which were tentatively interpreted to be south facing, were noted on Bancroft Lake. The rocks have been generally metamorphosed to upper greenschist–lower amphibolite facies of regional metamorphism. Greenschist facies metamorphism is more pronounced where the Dempster-Pickle Lakes belt merges with the Meen-Dempster Lakes belt. A thin section of mafic metavolcanics collected in the southwest corner of Bancroft Lake is visually estimated to contain 40-50 percent hornblende, 50-60 percent fine-grained untwinned plagioclase, and 5-10 percent quartz. A particularly massive amphibolite unit (mapped as a flow) has been noted at the south end of Kawinogans Lake.

On a small bay on the south end of Kawinogans Lake an outcrop of massive "feather" amphibolite was initially mapped as a metagabbro. This rock on weathered surface is composed of approximately equal amounts of acicular hornblende and clouded saussuritized plagioclase. It weathers grey-black and

the branching, dendritic pattern of the amphiboles make the outcrop particularly noticeable. The amphibole crystals are up to 2.5 cm in length and 1 to 2 mm in width.

In thin section the rock was identified as a quartz diorite. Thin sections parallel to the long axis of the dendritic amphibole crystals disclosed that the long crystals were actually a composite of a number of crystals which overlap each other as shingles on a roof. The end-on section indicated that the crystals are all twinned and that some have undergone post-crystallization fracturing.

The mode was visually estimated to be hornblende 40-50 percent, quartz 10-15 percent, plagioclase of andesine composition 20-30 percent, granophyre 20-30 percent, and trace of zoisite and carbonate. The abundant granophyre consists of a very fine intergrowth of quartz and plagioclase interstitial to the other mineral components. The larger quartz grains have an amoeboid outline. The amoeboid outline, interstitial granophyre, and evidence of fracturing suggests the possibility that the granophyre may have been introduced or is a replacement phenomena. The possibility cannot be ruled out that the texture represents an eutectic crystallization of a shallow quartz diorite intrusion. The rock has been mapped as intrusive quartz diorite.

FELSIC TO INTERMEDIATE METAVOLCANICS

Directly north of the northeastern extremity of Annimwash Lake, along the margin of the belt, is a small, poorly exposed unit of possible felsic to intermediate metavolcanics. In outcrop the rock is fine grained, foliated, and grey-white weathering. On fresh surface it is dark grey with thick discontinuous streaks of mafic segregations.

In thin section the rock was visually estimated to have the following mode: 5 percent biotite, 15-25 percent sericite, 0-5 percent carbonate, 25-35 percent fine-grained quartz, and 45-55 percent plagioclase of oligoclase composition. Trace amounts of magnetite and epidote were noted. The sericite occurs as porphyroblasts with plagioclase inclusions, and the quartz was noted to have a weak wavy extinction. The grain boundaries are weakly sutured to polygonized, indicating some degree of recrystallization.

On the south end of Kawinogans Lake felsic to intermediate metavolcanics were examined, which had not been indicated by previous geological surveys and are most likely correlative with those observed on Dempster Lake.

The felsic to intermediate metavolcanics at the south end of Kawinogans Lake are light green in colour with a darker hue on fresh surface. The rocks break with a schistose to crudely subconchoidal fracture and consist of massive to foliated varieties visually identified in the field as rhyolite to dacite. Quartz-sericite-plagioclase schists and pyroclastic rocks are both present. The pyroclastic units consist of subangular, brownish black, aphanitic, lapilli size fragments dispersed in a fine-grained dark grey weakly foliated matrix.

A thin-section of lapilli-tuff disclosed oblate plagioclase grains in a fine grained foliated biotitic matrix. A visual estimate of the mode is altered plagioclase phenocrysts 10 percent, carbonate 5 percent, biotite 35-45 percent, and a fine-grained mosaic groundmass of quartz and plagioclase 50 percent. Chlor-

ite and garnet are minor accessory minerals and thin quartz stringers were present. Texturally the rock is similar to those on Dempster Lake and this unit is interpreted to be part of the same felsic sequence.

METASEDIMENTS

A small unit of metasediments about 0.8 km in width and 4.8 km in length and completely enclosed within metavolcanics occurs on Whitmore Lake. Rocks in this unit are well layered, fine-grained, and weather grey-black. In thin section, a typical sample of this rock was visually estimated to contain 15-20 percent biotite, 5 percent sericite, 60-70 percent fine grained mosaic of untwinned plagioclase and quartz, and 5 percent sericite. The plagioclase is of oligoclase composition. Primary textures have been obliterated by recrystallization and growth of metamorphic minerals. This thin metasedimentary unit is thought by the writer to represent fine grained greywacke detritus derived from a predominantly volcanic terrain.

One of the larger metasedimentary bands straddles Carpenter Lake. These metasediments are medium grained, weather brown, and consist of well foliated to weakly foliated sericite-quartz and plagioclase-biotite schists and gneisses. The metasediments are locally cut by white to pale pink granitic pegmatites. The metasediments lack clear evidence of primary depositional structures. Two samples of metasediments from Carpenter Lake were examined in thin section. The sections indicated somewhat contrasting compositions. One section was visually estimated to contain 35-40 percent hornblende, 5-10 percent zoisite, 20-25 percent quartz, 10-15 percent partially chloritized biotite and 30-35 percent plagioclase of oligoclase-andesine composition. Trace amounts of carbonate and microcline were also present. The second thin section was visually estimated to contain 30-40 percent sericite, 16-20 percent biotite, 20-30 percent quartz and 30-35 percent plagioclase of oligoclase composition. The quartz was observed to have a wavy extinction and the quartz-feldspar grain boundaries are irregular and somewhat sutured. Foliation surfaces of the sericite-bearing sample defined by biotite plates and recrystallized quartz. Bending of the sericite crystal plates is common. This unit is estimated by the author to be approximately 10 km in length, to average 0.8 km in width and to be of largely greywacke composition most probably derived from a volcanic terrain.

Another southwest-trending belt of metasediments begins at Kasagiminnis Lake, passes through Wincott Lake, and terminates southwest of Wincott Lake. The metasediments are brown to brownish black weathering and consist of siltstone, argillite, arkose, greywacke and conglomerate. This metasedimentary unit is interpreted to be 8 km long and 0.8 km wide.

An occurrence of conglomerate is exposed on the northeast shore of Wincott Lake. This conglomerate is polymictic, consists of pebble to cobble size clasts in a greywacke matrix, and occurs in a unit approximately 75 m thick. It occurs in association with quartz-feldspar-biotite schists of argillite or greywacke composition. The pebbles and cobbles in the conglomerate are elongated in the horizontal plane up to 15 cm in length and average 3 to 5 cm in width. The coarse

clasts are elongated and flattened parallel to bedding with maximum elongation plunging steeply northeast at 45-70 degrees. The matrix of the conglomerate is biotitic and the pebble-cobble rock types are visually estimated to be massive, medium grained, equigranular trondhjemite (10-15 percent), massive, medium grained, equigranular amphibolite(≅5 percent), fine grained massive equigranular mafic metavolcanics(≅5 percent), massive light grey to buff fine grained equigranular felsic metavolcanics (70 to 80 percent), reddish vein quartz (up to 1 percent), and sacchroidal fine grained, light grey to buff with rusty streaks recrystallized chert (≅17 percent). Thin discontinuous silty beds, less than 13 cm thick, occur within the conglomeratic horizon and the outcrop is cut by coarse grained massive granitic pegmatites.

In a thin section of matrix plus a felsic pebble it was visually estimated that the matrix was composed of 30-40 percent biotite, 5-10 percent hornblende, and 50-60 percent fine grained mosaic of quartz and plagioclase. The felsic pebble consisted of a fine grained mosaic of quartz and untwinned plagioclase. The conglomerate has been metamorphosed to upper greenschist-lower amphibolite facies of regional metamorphism. The predominance of volcanic clasts in this conglomerate indicate a dominantly volcanic source area. The presence of felsic volcanic and chert clasts, in addition to clasts equivalent to the mafic volcanic rocks exposed in the area, indicates that felsic volcanic rocks are present in the region but are not exposed or were present but have been removed by erosion. The medium grained, equigranular, massive trondhjemite pebbles could be derived from either the surrounding granitic terrain or from granitic stocks intruded into the volcanic-sedimentary sequence.

A unit of possible metasedimentary rock occurs on the north end of Annimwash Lake. This unit is estimated to be approximately 6.5 km long and 0.8 km wide. The rocks exposed here are medium to dark grey on weathered surfaces, well foliated, fine grained and have biotite concentrated along some foliation planes. In thin section, a sample from this unit was visually estimated to contain 5-10 percent biotite, 40-45 percent hornblende, 45-50 percent plagioclase, and possibly 5 percent quartz. The rocks of this unit are very probably derived from mafic volcanic material. The formation probably represents mafic volcanic detritus or waterlaid tuffs.

IRON FORMATION

Iron formation was not observed in outcrop. A linear magnetic trend of about 66 000 gammas magnitude, west and southwest of Skebo Lake, is interpreted to indicate iron formation (Map 923G, ODM-GSC 1960).

QUARTZ-FELDSPAR PORPHYRY

On a small unnamed lake at the eastern end of the granitic mass which separates the Dempster-Pickle Lakes belt into two parts is a small body of quartz-feldspar porphyry. The dimensions of this unit have not been accurately established. The porphyry occurs along the north contact of the southern mass of me-

tavolcanics-metasediments. In outcrop the rock is porphyritic, grey-white, well foliated, and fine to coarse grained. In thin section it is visually estimated that the rock consists of 5 percent carbonate, 5-10 percent zoisite, less than 5 percent biotite, 10-15 percent sericite, 25-35 percent fine grained quartz, 25-30 percent plagioclase phenocrysts of oligoclase composition, and approximately 30 percent fine-grained untwinned plagioclase feldspar. The larger plagioclase grains are oblate or subspherical in outline and partially altered to sericite. The quartz grains display a wavy extinction and the fine grained quartz-plagioclase ground mass has sutured grain boundaries. On the weathered outcrop surface bluish grey quartz phenocrysts up to 4 mm in diameter occur, but these were not observed in thin section. The rock could be either a highly sheared, recyrstallized, trondhjemitic phase of the bordering granitic mass or a sheared porphyry intrusion along the contact between the "greenstone" belt and granitic rocks. It has been mapped as the latter.

Structural Geology

The structure of the Dempster-Pickle Lakes belt is undoubtedly complex and the lack of outcrop is a hindrance to structural interpretation. The southern portion of this belt in the vicinity of Dempster Lake and Jacknife Lake occurs at the junction of the Meen-Dempster Lakes belt, Bamaji-Fry Lakes belt, Johnson Bay-Fry Lake belt, and the Dempster-Pickle Lakes belt. These belts are interpreted as being dominately synformal in nature. The junction of these belts is also thought to be basinal or synformal in nature even though supporting data is lacking. Local modification of this junction is likely due to the emplacement of the Kawashe Lake, Graniteboss Lake, and Duffel Lake granitic stocks.

Data on the granitic terrain north of this belt near the southern portion of Kawinogans Lake is sketchy. Cataclastic textures are present indicating at least local fault control of the supracrustal-granitic terrain contact. The interpretation of migmatized supracrustal rocks in this area is based on isolated helicopter stops, aeromagnetic maps, and exploration data provided to the authors by Union Minere Explorations and Mining Corporation Limited (E. Reeves, personal communication).

One sample of granitic rock marginal to the belt at Kasagiminnis Lake was thin sectioned and was found to have a cataclastic texture. The rock was visually estimated to be composed of 5-10 percent epidote-zoisite, 45-50 percent plagioclase of andesine composition, 5-10 percent biotite, 25-30 percent quartz, and 5-10 percent sericite. Minor chlorite is also present. The foliation in the rock is defined by the micaceous minerals and recrystallized quartz. The quartz displayed only weak undulatory extinction. The rock is a moderately sheared and recrystallized quartz diorite.

The thin section of a sample collected marginally to the Duffell Lake stock reveals that this rock is silicified and was visually estimated to be composed of 70-80 percent partially chloritized biotite, with 20 to 30 percent vein quartz and 10 to 20 percent inequigranular fine to medium grained quartz. It weathers a rusty brown and on fresh surface it is a dark grey brown with a well developed

foliation. Minor opaques are present. The rock has been moderately sheared with the foliation being defined by the micaceous minerals. The quartz has a wavy extinction and mosaic texture.

Economic Geology

Very little mineral exploration attention has been directed to the bulk of this belt until recently. In the early 1950s, gold was discovered by the late K. Koval and B. Ohman near Bancroft Lake (Don Koval, personal communication, Pickle Lake). During 1953-1954, this prospect was optioned by Hasaga Gold Mines Limited. Extensive trenching and 87 diamond drill holes totalling 6365.8 m outlined a deposit containing 135 000 tonnes averaging 6.51 g/t gold and 37 000 tonnes averaging 4.80 g/t gold (Assessment Files Research Office, Ontario Geological Survey, Toronto). This deposit is currently controlled by the Little Long Lac Gold Mines Limited.

During 1969, Newconex Canadian Exploration Limited conducted ground electromagnetic and geological surveys on five claim groups (126 claims total) in the Graniteboss Lake-Duffell Lake area (File 63.2807, Assessment Files Research Office, Ontario Geological Survey, Toronto). Interest in these claim groups was abandoned after apparently negative results.

Union Miniere Explorations and Mining Corporation Limited, during 1971-1972, conducted extensive ground geophysical and diamond drilling surveys in the Wright Lake, Caley Lake, Minonainatik Lake, and Kawashe Lake areas. At least 4465 m of diamond drilling has been recorded to date (Diamond drill records, Assessment Files Research Office, Ontario Geological Survey, Toronto, and UMEX private diamond drill logs). No important discoveries had been documented to the time of writing by this company in the Dempster-Pickle Lakes belt.

PICKLE LAKE BELT

Outcrop in the Pickle Lake belt is very limited. Outcrop density is much less than one percent with the best exposures being in the vicinity of the former Central Patricia and Pickle Crow mines. Some outcrop occurs in the First Loon and Second Loon Lakes and July Falls area. Mapping consisted of lakeshore and river traverses and limited ground traverses into outcrop areas previously indicated by helicopter reconnaissance.

The Pickle Lake belt is ramiform in shape, consisting of a number of lobes and branches of metavolcanics with intercalated metasediments striking east and northeast. One lobe strikes almost due east from Pickle Crow to First Loon and Second Loon Lakes, another northeast to July Falls, and a third east of and north to and beyond Tarp Lake. The belt interdigitates with the granitic rocks of the surrounding area and one lobe striking southwest possibly joins up with the Meen-Dempster Lakes belt at the southern extremity of Kawinogans Lake. To the south the belt merges into the Osnaburgh-Pickle Lakes belt.

The Pickle Lake belt consists dominantly of mafic to intermediate metavol-

canics, locally pillowed, ranging from greenschist to upper amphibolite facies in metamorphic grade. An extensive mass of felsic to intermediate metavolcanics, of dacitic composition occurs within the general vicinity of the Pickle Crow mine. Thin units of iron formation are intercalated with the metavolcanics and metasediments throughout the belt. Minor amounts of intercalated metasediment of greywacke composition were noted but no major metasedimentary units were delineated.

Ultramafic rocks occur in association with copper-nickel mineralization at Union Miniere Explorations and Mining Corporation Limited's Thierry deposit and Kapkichi Lake deposits but such rocks were not observed in outcrop. Two quartz-feldspar porphyry stocks, the Pickle Crow porphyry and Albany River porphyry, have concordantly intruded the metasediments and metavolcanics in the vicinity of the Pickle Crow mine. At July Falls a mafic intrusion varying in composition from gabbro to quartz diorite is indicated from limited outcrop data. The metavolcanics and metasediments have been intruded by granitic rocks of the Pickle Lake and Hooker-Burkoski stocks.

Folding within the Pickle Lake belt is isoclinal and dominated by the Pickle Crow syncline and Central Patricia anticline. The folds plunge northeasterly and have been cross-folded about a northwest-southeast axis (Pye 1952, p.50-51), related to domical emplacement of the Hooker-Burkoski stock.

Previous work in the area has been done by Thomson (1939), Hurst (1930), Evans (1941), Pye (1956), and Ferguson (1966).

In reference to Pye's (1956) work Figure 12 gives the locations of claims and properties referred to in the text of the report. The reader may also find Preliminary Map P.1009 to be of additional interest with respect to the geology and structure of the Crow River area (Pye 1975).

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics identified in the field as basalt to andesite in composition are the dominant rock-type within the Pickle Lake belt. The rocks are generally fine-grained, massive to schistose and vary from light green to grey-black on weathered surfaces. The metavolcanics contain well preserved but considerably elongated pillow structures south of the Pickle Crow townsite and south of July Falls. Except in a few localities, the pillows are so highly elongated that they are of little value for stratigraphic-structural purposes.

Observations by members of this field party confirm Pye's (1956, p.17) observation that the mafic to intermediate volcanic rocks generally lack primary textures. Pye (1956, p.17) also reported the presence of porphyritic and variolitic mafic to intermediate rocks and Thompson (1939, p.6) reported amygdaloidal varieties, however, these porphyritic, variolitic and amygdaloidal varieties were not seen by members of this party and thus are presumed to be of only local distribution.

The more massive conformable mafic to intermediate units were interpreted by Pye (1956, p.18) and by members of this project as being thick flow centres, but they are essentially indistinguishable in texture or mineralogy from rocks of possible intrusive nature. The more schistose mafic to intermediate rocks consist of either chlorite or hornblende with the hornblende varieties being restricted to the granite-greenstone contact and are presumably a function of increasing metamorphic grade along the contact (Pye 1956, p.20-21). Pye (1956, p.20-21) interpreted the chlorite schists as occurring along 1) faults, and 2) formational contacts and the authors concur with this interpretation.

Mafic to intermediate pyroclastic rocks, flow top breccia, and tuff were reported (Pye 1956, p.23-26) to be present in the central portion of the belt, along McCullagh Creek, along the former power line south of the Central Patricia No.1 shaft, north of the Central Patricia mine, on the former Winoga claims, and on the former Crowshore property which abutted against the north side of the Albany River property (Figure 12). The reader should refer to Pye's report (1956) for a description of these lithologic units.

On fresh surfaces the mafic to intermediate metavolcanics are light green to black. The light-green colour is characteristic of rocks of the greenschist facies of metamorphism, while black is more characteristic of those of amphibolite facies.

At Pickle Crow the metavolcanic-metasedimentary belt is approximately 10 to 12 km wide. The mafic to intermediate metavolcanics of the central portion of this belt are characterized by chlorite, actinolite, and epidote-zoisite. Towards the margins of the belt, or where the belt thins as it branches towards the east and northeast into various lobes the mineralogy changes to plagioclase (generally untwinned), hornblende, and epidote-zoisite reflecting an increase in metamorphic grade. Minor amounts of quartz are commonly present in some of the amphibolite metavolcanics suggesting an andesitic composition.

At the contact of the metavolcanics and granite is migmatite consisting of mafic metavolcanics and granitic injections. In one thin section the granitic portion of the migmatite was visually estimated to contain 10-15 percent quartz, 25-35 percent zoisite, 5 percent hornblende, and 40-50 percent plagioclase of andesine composition. Zircon and garnet were noted as accessory minerals. The mixed nature of rocks along the metavolcanic-granite contact would give a widely varying mineral composition even between thin sections prepared from the same sample. Increasing grain size accompanies increasing metamorphic grade and close to the metavolcanic-granite contact, the amphibolites locally are banded. The banding is caused by a slight segregation of mafic and felsic components.

The metavolcanics south of Kawinogans Lake in the Dempster-Pickle Lakes belt display a variation in metamorphic grade with respect to the granite-metavolcanic contact similar to those in the Central Patricia-Pickle Crow area and surrounding vicinity. As pointed out by Pye (1956) the colour of the metavolcanic rocks is dependant on deformation and degree of metamorphism, but may also result from alteration such as carbonatization or silicification. Thus care must be exercised where mapping since all compositionally dark coloured rocks may not be mafic or all light coloured rocks felsic.

FELSIC TO INTERMEDIATE METAVOLCANICS

Within the Pickle Crow area felsic to intermediate metavolcanics include fine-grained tuff to agglomerate and breccia. On weathered surface the felsic to intermediate rocks are light grey-green to grey. On fresh surfaces darker hues of the same colours are characteristic. Within the Pickle Crow mine area Pye (1956, p.19-20) described the felsic to intermediate metavolcanics as 1) fine-grained, brownish grey, porphyritic dacitic rocks with minute phenocrysts of albite and quartz, and 2) fine-grained pale grey, massive lavas of probable rhyolite composition. The dacitic rocks occur near the Springer mine on the former Albany River group and south of the Central Patricia No.1 shaft (Pye 1956, p.19-20). The rhyolitic appearing rocks are located on the Pickle Crow Main and Albany River claim groups and on the Crowshore property north of the Albany River property (Pye 1956, p.19-20).

Pyroclastic rocks visually identified as felsic to intermediate form a major lithologic unit in the Pickle Crow mine area. Pye (1956, p.22-23) described these rocks as consisting of fragments, varying from a fraction of an inch to several inches in size, of light to dark coloured rock set in a fine-grained tuffaceous matrix. These rocks consist of two types: a more felsic oligomictic variety of rhyolitic composition occurs along Dona Creek on the Dona Patricia claims, and a more mafic, polymictic variety is found east of the Central Patricia No.1 shaft, on and east of the Winoga claims, and southwest of the shaft on the Albany River property.

Thompson (1939, p.7) reported that narrow discontinuous units of fragmental rocks are widespread and form a major unit east and west of the Hooker-Burkoski Stock. A thin-section was prepared from a felsic metavolcanic fragmental unit which outcrops about 3 km east of the Hooker-Burkoski stock. The fragmental unit is pale green to grey on fresh surface and consists of approximately 60 percent matrix and 40 percent fragments. The fragments vary from 2 mm to 30 cm in long dimension. The rock appears porphyritic on outcrop surfaces. This rock is visually estimated to consist of 20-25 percent plagioclase of andesine composition, 5 percent quartz, and more than 50 percent groundmass consisting of a fine grained mosaic of quartz and untwinned plagioclase. Carbonate is present and zoisite is an abundant alteration. The quartz phenocrysts within the clasts are polycrystalline and the plagioclase phenocrysts within the clasts are clustered, i.e. glomeroporphyritic.

Two thin-sections were prepared from tuffaceous felsic to intermediate metavolcanic samples collected approximately 0.8 km southwest of the main Pickle Crow shaft. On weathered surface the samples are light grey-green with fragments up to several millimetres in length in long dimension. In thin-section the rocks are visually estimated to be composed of 15-20 percent carbonate, 1-15 percent quartz as irregular grains with wavy extinction, 0-20 percent zoisite as an alteration of plagioclase, and 50-65 percent fine-grained quartz-plagioclase mosaic. One sample contains 5-10 percent dark brown irregular wispy particles thought to be representative of former mafic fragments. The thin section lacking the more mafic clasts does not show well developed clastic textures in thin section, but the weathered surface would indicate that it is composed of predominantly lens-like felsic fragments up to 4-5 mm in length. Compositionally the rocks are thought to approximate dacite.

METASEDIMENTS

Minor amounts of metasediments are present throughout the Pickle Lake belt. The metasediments are dominantly of greywacke composition and are intercalated with the metavolcanics. The greywacke has been metamorphosed to biotite-quartz-plagioclase schist. An occurrence of metasediments in the Pickle Crow area was described by Pye (1956, p.26-27) as fine-grained slaty greywacke with individual beds ranging from a fraction of an inch to about 6 inches in thickness. In thin section the rock is found to be composed of fragments of quartz and plagioclase in a schistose matrix of sericite, calcite, carbonate, and leucoxene (Pye 1956, p.26-27). Pye (1956, p.26-27) also noted that this unit was a much lighter grey in colour and more distinctly laminated than other units interpreted as mafic tuff. There is a possibility that this unit represents a waterlaid felsic ash closer to a pyroclastic than an epiclastic origin. The laminations are wispy and somewhat discontinuous and the foliation crosscuts the laminations at a very slight angle. The units examined above and below this fine grained laminated horizon are considered to be volcanic in origin, mafic to the south and felsic to the north.

Thompson (1939, p.9, 11) described some metasedimentary units, encountered in diamond drilling for gold mineralization, as greywacke, quartzite, and graphitic schist. These drill-indicated metasedimentary units occur in widths up to 20 m.

Thompson (1939, p.9) mentioned 100 feet (30 m) as being the maximum observed thickness for a sedimentary unit. Metasediments are distinctly a minor component of the Pickle Lake belt. In no place were metasediments found in sufficient quantity to form a mappable unit at the mapping scale of 1 inch to 2 miles (1:126 720).

IRON FORMATION

Iron formation in discontinuous bands intercalated with metavolcanics and metasediments is common in outcrop exposures within the Central Patricia-Pickle Crow area. Hurst (1930, p.7) reported unit widths up to 75 m in thickness. Pye (1956, p.27-29) described the iron formation occurrences for the Pickle Crow mine area as strikingly banded, rusty weathering rock consisting of thin layers of iron carbonate, fine grained quartz, and magnetite in widely varying proportions. Individual units occur as streaks, lenses, and bands from a few centimetres to over 30 m in width (Pye 1956,p.27-29). Thompson (1939, p.11) also noted that even though individual units are lenticular and extend only a few metres, they are often arranged in linear patterns permitting delineation of stratigraphic horizons needed to unravel structural features. The iron formation may consist of a single lithologic unit or of several bands separated by thin units of tuff or thin flows (Thompson 1939, p.11). While the relatively low iron content suggests little economic importance as a source of iron, fractures in and along contacts of iron formations have contained commercial gold ore (Pye 1956, p.28-29).

Hurst (1930, p.8-10) described the iron formation of the area as being made

up of alternating layers which are light-grey buff, greenish brown or black in colour on fresh surface. The light coloured layers consist of finely laminated silica with minor iron carbonate; the grey or brown layers contain abundant iron carbonate, some silica, and little magnetite; and the dark grey or black bands contain abundant magnetite relative to the other constituents (Hurst 1930, p.8-10). Where the iron formation has been fractured pyrrhotite and occasionally pyrite occurs replacing the iron carbonate and filling minute cracks (Hurst 1930, p.8-18).

A prominent linear magnetic anomaly (ODM-GSC 1960, Maps 924G and 934G) striking northeast from Pickle Crow to Collishaw Lake area is interpreted to be iron formation. Magnetic intensities along this linear feature reach 68 000 gammas total field intensity. Minor, thin units (generally less than 3 m thick) of iron formation were noted by members of this party throughout the area but are of only local significance.

MAFIC INTRUSIVE ROCKS

Numerous occurrences of massive, medium to coarse grained metadiorite or metagabbro of possibly intrusive origin occur in the Pickle Lake belt. The interpretation as to whether these units are representative of sill-like intrusions or thick flow centres is often very subjective. Generally, these units are included with the flows.

Within the Pickle Crow area, Pye (1956, p.29-30) has discussed at some length the problem of whether outcrops of massive appearing mafic rock are extrusive or intrusive in nature. Members of this party followed criteria similar to those of Pye (1956) in that if an intrusive relationship could be established the unit was mapped as such, in other instances where the intrusive nature could not be established the exposures were mapped as mafic flows. Compositionally, and texturally the mafic intrusive rocks and mafic flows are similar.

Pye (1956, p.30) reported gabbro porphyry in the underground workings of the Crowshore mine but the rock-type has not been located at surface. This rock contains white to cream-coloured phenocrysts up to 5 cm in length of highly altered plagioclase embedded in a dark green, fine grained matrix of feldspar, chlorite, amphibole, sericite and accessory magnetite (Pye 1956, p.30).

At the northeast extremity of the lobe striking northeast to July Falls is an intermediate to mafic intrusion estimated to be 8 km^2 in area. This body is referred to as the July Falls mafic stock. The outcrop density is less than one percent and the limits of the stock are ill defined, being based on scattered outcrops and aeromagnetic interpretation. The long axis of the intrusion parallels the foliation of the metavolcanics and its contact with the metavolcanics is the locus of considerable shearing making the distinction between metavolcanics and the diorite-gabbro difficult, if not impossible. Evans (1941, p.5) was the first investigator to examine this body, but he gave few details.

Reconnaissance mapping has indicated the presence of a mafic intrusion visually identified as ranging in composition from hornblendite to gabbro, diorite, and quartz diorite. The intrusive body appears to be zoned from gabbro and diorite in the east to quartz diorite and trondhjemite in the west with other associated rock types being of only local minor occurrence. It is uncertain

whether the intrusion is composite or a single phase that has differentiated in place. The texture is generally medium grained with some coarse grained phases. A finer grained texture near the contact suggests the presence of a chilled margin. Dikes and sills related to the intrusion were not found. Locally the intrusion is cut by narrow shear zones, and minor drag folding accompanies the shearing.

On the weathered surface the gabbroic-dioritic rocks in the east are grey to grey-black and on fresh surface lighter hues of the same colour. The quartz-bearing phases to the west are light brown to pinkish brown on weathered surface and pinkish brown on fresh surface. A thin section prepared from a coarse grained hornblendite sample disclosed the following visually estimated mode: fine grained interstitial plagioclase 5-10 percent, hornblende 85-90 percent, chlorite 1-2 percent, and carbonate 1-2 percent. A thin-section prepared from a sample, taken 4 km southeast of Collishaw Lake, of the more mafic phase of the July Falls stock which had been mapped as gabbro in the field, had the following visually estimated mode: plagioclase of andesine composition 50-60 percent, pyroxene altering to hornblende 30-40 percent, and chlorite 2-3 percent. The pyroxene has undergone uralitization and chlorite occurs as an alteration of the hornblende. The plagioclase grains display bent albite twin planes and very moderate microfracturing. The relict pyroxene has an amoeboid outline where in contact with the enclosing hornblende. The contact between hornblende and pyroxene is a relatively sharp, very thin (0.1 mm) transition zone. The uralitization of the pyroxene is thought to be primary, either a reaction relationship or late stage deuteric rather than one representing a much later metamorphic event. The rock is a medium-grained, massive, equigranular, hypidiomorphic pyroxene diorite.

Somewhat less than 1.5 km southeast of the outcrop from which the pyroxene diorite sample was collected a sample was taken from outcrop along the road at July Falls. In thin section, the rock was visually estimated to contain 15-25 percent quartz, 5-10 percent biotite, 20-25 percent hornblende, and 50-60 percent altered plagioclase. A trace of relict pyroxene was noted and the plagioclase often displays a weak zonation. The plagioclase displays considerable alteration to zoisite, bending of the albite twin planes, and microfracturing. Alteration of the plagioclase was sufficiently pervasive as to prevent determination of its composition by optical techniques. Several biotite grains have well developed kinking of the 001 cleavage plane. The quartz is very fine grained, interstitial and has irregular sutured grain boundaries between individual grains. The quartz is either a product of very late crystallization or has possibly been introduced. The sample was cut by a slip plane defined by a fine-grained mixture of chlorite and epidote. The rock is metamorphosed and has undergone weak to moderate cataclasis. Its texture may have originally been similar to that of the pyroxene diorite. The rock is presently quartz diorite in composition.

A thin-section was prepared from a third sample collected about 0.4 km southwest of the quartz diorite sample. In thin-section the mode was visually estimated to be 25-30 percent quartz, 10-15 percent chloritized biotite, 5 percent microcline and 45-50 percent plagioclase of oligoclase composition. The quartz occurs in two distinct forms: 1) in minor amounts as a fine-grained interstitial mosaic with interlocking sutured grain boundaries similar to those observed in the quartz diorite sample; and 2) predominantly as larger intersti-

tial grains more typical of normal granitic rocks. The fine-grained interstitial quartz with the sutured grain boundaries may be in part of secondary origin and the coarser grained quartz primary. The quartz also displays a wavy extinction. The plagioclase which has altered to zoisite and sericite occasionally is weakly zoned. Approximately 10 percent of the potassic feldspar grains display a wispy perthitic intergrowth of plagioclase(?) feldspar. The orientation of the wispy perthite growths suggests that their location may be controlled by minute fracturing within the feldspar grains. The rock would be best described as massive, medium-grained, equigranular trondhjemite-granodiorite.

In summary, the July Falls mafic stock displays weak to moderate cataclasis and is a zoned intrusion varying in composition from pyroxene-bearing diorite in the east to granodiorite in the west. Both primary and metamorphic textures are present.

ULTRAMAFIC INTRUSIVE ROCKS

Ultramafic rocks as such were not observed in outcrop within the Pickle Lake belt; however, they do occur in association with the Thierry copper-nickel deposit and the Kapkichi Lake deposits. The ultramafic rocks are associated with amphibolites and probably represent conformable intrusions into a mafic volcanic sequence.

Beneath Kapkichi Lake diamond drilling by Union Miniere Explorations and Mining Corporation Limited has intersected ultramafic rocks with low grade copper-nickel mineralization. Verbeek *et al.* (1972, p.137) described these ultramafic occurrences as follows:

> Drilling of these anomalies defined masses of ultrabasic rock with minor gabbro, uniformly mineralized with grades of about 0.40% Cu and 0.13% Ni. Metamorphism is extensive, but the composition indicates a range of lithology from dunite to gabbro, with harzburgite most abundant. Fresh samples show cumulus textures with sulphides (pyrrhotite, pentlandite, chalcopyrite and cubanite) and magnetite in an intercumulus relationship. Rarely 'droplets' of sulphide occur in olivine.

Verbeek *et al.* (1972, p.139) described the ultramafic rocks associated with the Thierry deposit as follows:

> Associated intrusives: At the east end of the deposit is a mass of ultrabasic rock, almost entirely metamorphosed; the predominant type is a tremolite-chlorite rock with diablastic[1] texture, carrying abundant magnetite, a little ilmenite and local traces of sulphides, mainly pyrrhotite. On the south side of the deposit, near the west end, is a smaller ultrabasic mass, here varying from light green tremolite-chlorite rock to darker green actinolite rock, which grades into metagabbro, consisting of hornblende and plagioclase with blastophitic[2] texture.

Members of the present field party noted a mineralized zone 3.7 m wide on the south central shore of Kapkichi Lake in association with amphiboli

[1]Diablastic: pertaining to a texture in metamorphic rock that consists of intricately intrown and interpenetrating constituents with rodlike shapes (AGI 1972, p.192).

[2]Blastophitic: a relict texture in a metamorphic rock in which traces of the original op texture remain (AGI 1972, p.79).

which have ultramafic affinities. This zone is on the former Kapkichi Nickel Mines Limited property, and is the original Thompson-Landmark Gold Mines Limited showing. Samples were not examined in thin section.

MIGMATITE

On the basis of aeromagnetic data, a migmatized extension of the Pickle Lake belt has been interpreted to extend east from the Loon Lakes area.

QUARTZ-FELDSPAR PORPHYRY

Within the general area of the Pickle Crow mine two quartz porphyry intrusions are known to exist. The larger body is known as the Pickle Crow Porphyry and occurs immediately north of the Pickle Crow mine No.3 shaft. The second porphyry is known as the Albany River Porphyry and it occurs approximately 450 m east-northeast of the Pickle Crow mine No.3 shaft. The Pickle Crow Porphyry has an approximate surface area of 0.42 km^2 and the Albany River Porphyry 0.028 km^2. Other minor outcrops of quartz porphyry are known to occur in the Central Patricia-Pickle Crow area. The following descriptions of the porphyritic rocks are paraphrased from Pye (1956, p.31-42) except where specifically attributed to the present field party.

Pye (1956, p.31-37) described the quartz porphyries and associated quartz sericite schists in some detail. These porphyry bodies are more or less lenticular in form, and while generally conformable with the strike and dip of the enclosing formations local transecting features are present.

The rock typically is white to grey-white on weathered surface with ovoid quartz phenocrysts (Photo 15) up to 1.5 cm in diameter weathering in relief. On fresh surfaces the rock is grey to pinkish grey in colour. While feldspar phenocrysts are ubiquitous in thin section (see Photo 15) they are not generally recognizable on the outcrop surface due to extensive saussuritization. The quartz porphyry is thus in reality quartz-albite porphyry.

In thin section these feldspar phenocrysts are seen to be small (10 mm), stout, well formed but fractured, crystals of albite (An_{04}). These crystals are much smaller than the quartz phenocrysts and from Rosiwal analysis were calculated to comprise 25 volume percent of rock compared with only 10 volume percent for quartz. The matrix of the phenocrysts consists of aggregates of tiny anhedral grains of quartz and altered plagioclase with accessory magnetite-ilmenite, leucoxene, apatite, sphene, and rutile. In thin section, the groundmass is schistose with the foliation being defined by parallel wisps, flakes and patches of sericite and chlorite. The porphyry has a distinct greenish tint where chlorite is a prominent constituent. Carbonate is an abundant component replacing the albite phenocrysts and groundmass feldspars. Table 8 gives a complete rock analysis of a typical quartz-albite porphyry.

The quartz-albite porphyries have all been sheared to widely varying degrees with the more massive varieties being the most favourable for gold min-

TABLE 8 CHEMICAL ANALYSES (WEIGHT PERCENT) OF QUARTZ–ALBITE PORPHYRY AND EQUIVALENT SCHISTS PICKLE CROW AREA (FROM PYE 1956, p. 33,35). ANALYSES BY PROVINCIAL ASSAY OFFICE, 1952. SAMPLES COLLECTED BY E. G. PYE.

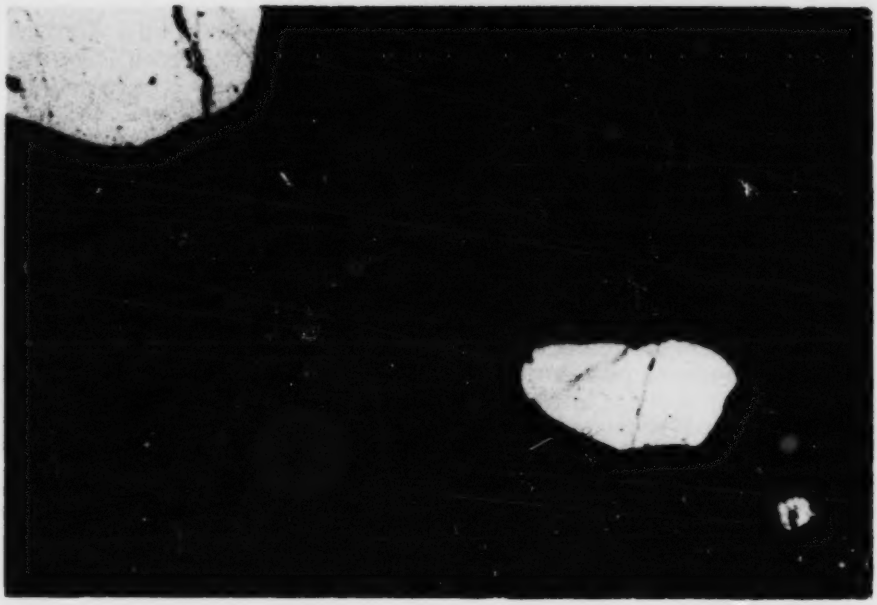
OXIDE	1	2	3
SiO_2	70.50	68.25	68.95
Al_2O_3	16.21	14.55	14.21
Fe_2O_3	0.21	0.54	0.60
FeO	1.35	1.84	1.08
MgO	1.64	1.12	1.17
CaO	2.43	2.50	2.50
Na_2O	1.79	3.68	3.88
K_2O	1.38	2.00	2.06
H_2O	2.85	2.01	0.80
CO_2	1.22	2.69	4.21
TiO_2	0.18	0.24	0.18
V_2O_3	tr.	tr.	tr.
P_2O_5	0.07	0.36	0.08
Cr_2O_3	0.01	tr.	tr.
MnO	0.02	0.05	0.02
Total	99.86	99.83	99.75
Loss on Ignition	3.78	4.89	3.78

SAMPLES

1. Typical quartz-albite porphyry, 55-foot level, Pickle Crow No. 2 operation.
2. Quartz-sericite schist, Central Patricia No.1 shaft area.
3. Altered quartz-albite porphyry, Central Patricia No. 1 shaft area.

eralization. The intrusive nature of these bodies is indicated by chilled margins along contacts with the enclosing wall rocks, by cross-cutting relations, and by irregular xenolithic inclusions of metavolcanics. Pye (1956, p.34) from his study of the conformable but variable intensity of shearing within the various porphyry bodies concluded that they were deformed concomittant with the enclosing rocks even though their emplacement need not have been simultaneous. The more massive porphyries may be slightly younger in age than the more deformed.

Within or close to the No.1 shaft of Central Patricia gold mine, quartz sericite schist occurs as sill-like masses and narrow dikes within the metavolcan-



OGS 10 272

Photo 15–Photomicrograph (10x) of Pickle Crow Porphyry. Rounded quartz phenocrysts and highly altered plagioclase phenocrysts in a fine grained polygonized groundmass of quartz and plagioclase feldspar. Sample from small outcrop north of the access road to the former Pickle Crow mine, approximately 1.6 km east of shaft. Pickle Lake belt.

ics. These schistose rocks appear similar to and are most likely genetically related to the quartz-albite porphyry. Chemical analyses of quartz-sericite schist and altered quartz-albite porphyry are given in Table 8.

While the quartz-albite porphyry locally exhibits knife-sharp contacts with the enclosing metavolcanics, it locally is gradational into quartz-sericite schist or quartz-chlorite-sericite schist. Pye (1956, p.35) also suggested that some units could have a sedimentary parentage because of their highly siliceous nature.

One sample of the Pickle Crow quartz porphyry was collected just north of the No.3 shaft by members of this party. A thin section prepared from this rock showed the petrographic features described previously by Pye. The quartz phenocrysts were noted to be broken and fractured. The quartz has a wavy extinction and the ghost-like outlines of the altered plagioclase grains are easy to distinguish from the enclosing matrix.

Pye (1956, p.40) described other porphyritic rocks in the Crow River area. These are massive feldspar porphyry bodies which were noted to occur 1) along Pickle Creek on the Gateway Patricia claims; 2) near the Howell vein on the

Pickle Crow Main group; 3) south of the highway in the vicinity of the Springer mine; and 4) to the east between Winoga and Roeanor Creeks. The feldspar phenocrysts are albite to sodic oligoclase in composition and occur in crystals up to 3 mm in length. Quartz phenocrysts are uncommon but present and the groundmass is made up of tiny grains of anhedral chlorite, carbonate, and very minor amounts of apatite, magnetite-ilmenite, leucoxene, and pyrite. The feldspar phenocrysts are fresh to slightly altered to sericite and carbonate. The albite porphyries are grey to brownish grey rocks which Pye (1956, p.40) postulated are related to the highly sheared quartz-albite porphyries. Pye (1956, p.40) also noted that at the Springer mine a gold-bearing vein cuts a body of albite porphyry indicating that their emplacement was pre-ore.

Also pre-ore in age are narrow dikes of quartz diorite porphyry which locally cut across folded structures without any change in attitude. These dikes are younger than the quartz albite porphyries. The quartz diorite porphyry is grey to dark-grey on fresh surface and contains phenocrysts of white feldspar and quartz up to 6 mm in diameter. The porphyry weathers pale-greyish to rusty brown and has as its most distinguishing characteristic the presence of large crystals and grains of lustrous black biotite which impart a speckled appearance to the rock. Microscopically, this quartz diorite porphyry is seen to contain phenocrysts of tabular corroded crystals of andesine, rounded ones of quartz, occasional grains of biotite, and locally some amphibole. The groundmass is an allotriomorphic aggregate of plagioclase, quartz and biotite, with accessory amounts of apatite, magnetite, and zircon. Some alteration of biotite to chlorite and feldspar to sericite, carbonate, and epidote was noted. Pye (1956, p.42) reported that quartz diorite porphyry occurs at 1) the Albany River property; 2) in the southeast corner of the Winoga group; 3) on claim PA2017 just off the nose of the Hooker-Burkoski stock, and 4) in the northeast corner of the Gateway Patricia property.

DIKE ROCKS

Felsic, mafic and lamprophyre dikes are reported from the Central Patricia-Pickle Crow area. In most cases they were not observed in outcrop during the present reconnaissance mapping of the area.

Pye (1956, p.42, 43) described narrow felsic dikes of aplite, rhyolite, and felsite in scattered locations. These dikes are not a major feature of the Pickle Lake belt and the reader should refer to Pye (1956, p.42, 43) for a discussion of them.

Mafic dikes of diabase composition and of narrow width have been encountered in the workings of the various gold mines of the district (Pye 1956, p.44). These dikes are fine grained, dark grey in colour, massive, and composed of a matted aggregate of chlorite, sericite, carbonate, magnetite, secondary quartz, and brown biotite (Pye 1956, p.44). These dikes are also a minor feature of the Pickle Lake belt and the reader should refer to Pye (1956) for a more detailed description. Pye (1956, p.45) gave two complete rock analyses for two samples collected from the mafic dike suite (Table 9).

TABLE 9 | **CHEMICAL ANALYSES OF DIABASE DIKE ROCKS.**

Oxides	Weight Percent	
	Sample 1	Sample 2
SiO_2	46.26	46.50
Al_2O_3	15.88	14.34
Fe_2O_3	0.83	Nil
FeO	7.32	10.70
MgO	3.92	5.00
CaO	8.42	8.45
Na_2O	3.24	1.99
K_2O	2.44	0.40
H_2O^+	3.15	3.65
H_2O^-	0.23	0.07
CO_2	6.53	7.07
TiO_2	1.10	1.55
V_2O_3	0.07	0.02
P_2O_5	0.14	0.21
Cr_2O_3	0.03	0.02
MnO	0.18	0.17
Totals	99.75	100.22
Loss on Ignition	8.96	9.82

Sample 1 — Analysis of "vein dike" 2,400 - foot level, Pickle Crow No. 1 Operation.

Sample 2 — Analysis of metadiabase dike (greenstone inclusion), 1,600 - foot level, Pickle Crow No. 2 Operation.

[1]Samples collected by Dr. E.G. Pye; Assay by Provincial Assay Office 1952.

Within the Pickle Lake belt Pye (1956, p.46) reported that small biotite lamprophyre dikes are numerous. These dikes cut sharply across the other rock formations but are still considered by Pye (1956, p.46) to be pre-ore. These dikes are massive, dark-grey to black, medium grained, and porphyritic with biotite phenocrysts that exceed 6 mm in diameter. Pye (1956, p.46) recognized two types of lamprophyre which are 1) a dike composed of biotite, orthoclase, chlorite, and carbonate; and 2) a dike composed of biotite, quartz, clinopyroxene, with accessory apatite and zircon. The reader should refer to Pye's (1956) report for additional data.

One of the more noticeable geological features of the map area is the Pickle Crow diabase dike which crosscuts several of the structural subprovinces of the map-area. This dike strikes northwest and can be traced on aeromagnetic maps for a strike length of several hundred kilometres (ODM-GSC 1970a, Map P.577). The Pickle Crow diabase dike passes just east of the Central Patricia shaft. This dike is a regional feature described in more detail under "Late Precambrian".

Structural Geology

Within the Pickle Lake belt outcrop density is very low, and combined with meager reliable stratigraphic data, any broad geological interpretation becomes highly speculative. Considerable exploratory work in the Pickle Crow-Central Patricia area in conjunction with outcrop data indicate a very complex structural history for this very limited area. Pye (1956) completed a detailed structural study of the Pickle Crow-Central Patricia area. Within the context of a reconnaissance survey of the present magnitude no attempt was made to modify or verify the work of Pye. The diamond drilling and exposures within the underground workings of the area's mines was unavailable to authors. The foregoing condensation of the more important features of the structural geology of the area is taken from Pye (1956) and the reader should refer to the original text for more detail. The reader may find preliminary map P.1009 to be of additional help in locating major geological and structural features (Pye 1975).

FOLDING

Whether the Pickle Lake belt as a whole is a monocline or syncline cannot be resolved with any certainty, however, based on the sharp convergence of lithologic formations near the centre of the belt towards the west Pye (1956, p.51, 52) has postulated that a regional syncline is present whose axial plane trends northeast through the approximate medial line of the belt. Pye (1956, p.52) in addition has postulated that this synclinal structure plunges in the direction of N65E with one branch striking northeast towards First Loon and Second Loon Lakes and the other branch striking east of north towards July Falls. These two branches are separated by a southwesterly trending tongue of granite (Pye 1956, p.52; Sage *et al.* 1973c).

On a smaller scale, fold structures of similar attitude are present and have been recognized within the vicinity of the formerly producing mines (Pye 1956, p.52-53).

Pickle Crow Syncline

The Pickle Crow Syncline has been defined in the vicinity of the Pickle Crow mine on the basis of folded iron formation units and its presence south of the Central Patricia is inferred from a combination of several features, i.e.: 1) schistosities; 2) pillow facing directions; 3) magnetic expression of iron formation; and 4) diamond drilling (Pye 1956, p.55). The axial plane of the fold strikes about N50E on the Pickle Crow "Main" group, bending into a east-west attitude near the southwest corner of the property where it has been cross folded by the emplacement of the Hooker-Burkoski Stock (Pye 1956, p.54). East of the Hooker-Burkoski Stock and south of the Central Patricia property the axial plane of the syncline strikes east with an abrupt swing to tne northeast where it was cross folded by the emplacement of the stock (Pye 1956, p.55).

The axial plane of this fold has been overturned and dips north at angles of 65 degrees at the Albany River mine, 80 degrees at the Pickle Crow No.1 shaft, and averages about 75 degrees (Pye 1956, p. 55). Pye (1956, p.56) postulated on the basis of measurements on drag folds that the larger Pickle Crow synclinal fold plunges about 70 degrees on the Pickle Crow property in the approximate direction of N20-30E and in a generally northeast direction at the Central Patricia shaft at an angle of about 60 to 65 degrees.

Central Patricia Anticline

The axial plane of the Central Patricia Anticline closely parallels that of the Pickle Crow Syncline and lies approximately 300 m northwest of the Pickle Crow synclinal axis in the vicinity of the Central Patricia property (Pye 1956, p.56-59). As with the Pickle Crow Syncline the axial plane of this fold is overturned to the north in the vicinity of the Central Patricia No. 1 shaft, dips 75 degrees north and strikes N77E (Pye 1956, p.56).

Thompson (1939, p.23) originally recognized this anticlinal fold structure as well as the Pickle Crow Syncline. Thompson (1939, p.23, Fig. 3) however postulated that the axial plane of the Central Patricia Anticline was folded around to a southwest strike and joined up with the Roeanor Anticline east of Pickle Lake and north of Dona Lake. Pye (1956, p.56-58) reinterpreted the data and based on 1) lack of regional deviation within the schistosity planes, 2) pillow facing directions, 3) magnetic expression, and 4) diamond drilling, concluded that the Central Patricia Anticline and Roeanor Anticline were not the same structure. Pye (1956, p.56, 57) proposed that the axial plane of this fold paralleled that of the Pickle Crow Syncline and was likewise folded about the Hooker-Burkoski Stock, but had a west-northwest strike west of the boundary between Ponsford and Connell Townships.

Cross Folds and Minor Folds

Pye (1956, p.59) recognized two cross fold structures in the area which occur at fold noses or between stock-like masses of granite. One cross fold, the Hooker-Burkoski Anticline, is the result of the deflection of formations about the Hooker-Burkoski Stock and its axis strikes N45W (Pye 1956, p.59). A second cross fold occurs between the Hooker-Burkoski Stock and the Pickle Lake Stock. This fold structure has been interpreted from magnetometer surveys tracing iron formation units and is referred as the Roeanor Anticline (Pye 1956, p.59). Pye (1956, p.59) postulated that the axial plane of the Roeanor Anticline strikes north or a few degrees west of north and that the fold axis plunges north at approximately 40 degrees.

Foliations in the amphibolitic mafic metavolcanics along the shore of Kapkichi Lake suggest that an anticlinal structure may be present which plunges to the north. The general outline of this structure is indicated by the sharp inflection in the outline of Kapkichi Lake.

FAULTING

Pye (1956, p.63) classified the faults into two groups: 1) longitudinal or strike faults which parallel the formations, and 2) transverse faults which cut across the formations. The longitudinal faults are the more important of the two.

Central Patricia Fault

The Central Patricia Fault has been traced by diamond drilling from the northeast corner of claim PA2193 on the Gateway Patricia property (see Figure 12) southeastward across Fault Creek and beyond the axial plane of the Central Patricia Anticline which it appears to offset (Pye 1956, p.63). This fault zone is 3 m wide, strikes N62W, and contains massive pyrite and pyrrhotite replacing sheared lavas and tuffs (Pye 1956, p.63). East of the Central Patricia mine this fault strikes N80W and cuts the formations in this area (Pye 1956, p.64). Pye (1956, p.64) also reported that where the fault cuts the Central Patricia anticlinal axis the shear zone is 9 m wide and is devoid of significant mineralization. The fault dips 70 to 75 degrees north throughout its length and is considered to be post-folding but pre-ore in age (Pye 1956, p. 64). Pye (1956, p.64) reported an apparent strike separation of 90 m on the axial plane of the Central Patricia Anticline with the north side moving east.

Pickle Crow Fault

Pye (1956, p.65), on the basis of 1) a deep linear depression at surface, 2) diamond drilling on claim PA630 indicating a strong shear zone, 3) diamond drilling on claim PA751 indicating a wide shear zone, and 4) diamond drilling on claim PA2062 of the Winoga claim group indicating a strong shear zone, has postulated the existence of a fault 3600 m in length which lies 120 m south of the Pickle Crow No.3 shaft and which passes a comparable distance north of the No.1 shaft. This northeast-striking fault is also considered to be pre-ore by Pye (1956, p.67) and contains sulphide mineralization replacing schistose metavolcanics and brecciated iron formation carrying minor gold values.

Crow River Fault

The Crow River Fault was first described by Thompson (1939, p.23-24) and occurs immediately north of the Central Patricia mine. This fault apparently offsets a porphyry body along the bed of the Crow River and gives the appearance of having apparently offset a diabase dike in the opposite direction east of the mine (Thompson 1939, p. 23-24). Thompson (1939, p.23-24) noted that if the faulting offset the diabase then it would mean that the regional folding and

possibly the mineralization was post-diabase which is highly improbable. Thus Thompson (1939, p.23-24) postulated that the faulting was pre-diabase, a conclusion supported by Pye (1956, p.70).

This pre-diabase fault strikes N80E, dips 75 degrees north and has a strike-slip separation of 30 to 45 m with north side east (Pye 1956, p.70).

With regard to the Pickle Crow diabase dike, an examination of aeromagnetic maps covering its southeastward extension (Maps 923G, 922G, 932G, and 933G ODM-GSC 1960) suggests that the dike consists of a series of *en echelon* segments. This suggests that a fault interpretation based on apparent displacement of segments of this dike would be in error (Thompson 1939, Map 47B). The apparently contradictory direction of movement on the Crow River Fault resulting from comparison of offset of the porphyry unit with offset of the Pickle Crow diabase dike perhaps arises because the dike was not offset by the fault but was emplaced *en echelon*. The true direction of movement and displacement is indicated by offset in the porphyry unit. Faulting would thus be pre-diabase as suggested by Pye (1956) and Thompson (1939, p.24).

Other Longitudinal Faults

Pye (1956, p.69) has postulated that a strike fault known as Cohen-MacArthur fault may be present on the Cohen-MacArthur property located in the northeast corner of the Pickle Crow area.

Transverse Faults

Within the Crow River area transverse faults strike northwest, roughly parallel to the axis of the Hooker-Burkoski Stock and dip northeast at angles between 60 and 75 degrees (Pye 1956, p.70) west of the Hooker-Burkoski stock. Movement along the transverse faults is right hand (east side south) whereas east of the stock it was left hand (Pye 1956, p.70). Pye (1956, p.68-69) postulated the presence of a transverse fault on the Dona Patricia claims and referred to it as the Dona Creek fault.

Verbeek *et al.* (1972, p.135) reported that the copper-nickel mineralization of the Thierry deposit occurs partly in a shear zone that transects the mineralized mafic and ultramafic rocks and then passes conformably into the surrounding mafic metavolcanics.

SHEARING

Pye (1956, p.60-62) correlated schistosity with shearing and has recognized two types. The most pervasive schistosity is axial planar and parallels the axial planes of the Central Patricia Anticline and Pickle Crow Syncline (Pye 1956, p.60-61). Superimposed on the regional schistosity is a later one that strikes parallel to the long axis of the Hooker-Burkoski Stock and dips northeast at 60

to 75 degrees (Pye 1956, p.61). Where both schistosities are present a pronounced lineation has developed, and in the vicinity of the Central Patricia No.1 shaft plunges 63 degrees in the direction N55E.

GRANITE-METAVOLCANIC CONTACT

The contacts of the metavolcanics with bordering granitic complexes are well exposed 1) north and south of Second Loon Lake, 2) approximately 6.4 km south of Pickle Crow, and 3) along the southern end of Kapkichi Lake. The dominant characteristic of the contact zone is migmatite and granitic intrusion. This contact zone varies from a metre to a hundred metres or more in width. The granitic material as determined visually from its mineralogy varies from trondhjemite to quartz monzonite in composition. The intrusions are both concordant and discordant, and occur marginally to the belt as dikes, sills, stringer veins, and *lit par lit* injections up to a hundred metres or more in width. On the southwest shore of Kapkichi Lake xenolithic quartz monzonite (visual identification) extends for more than 100 m across the metavolcanic-granite contact. The xenoliths vary from distinctly angular to partially assimilated schlieren of biotite-amphibolite. Locally the concentration of xenoliths exceeds 25 percent and locally may be classed as schollen structure (Mehnert 1968, p.10). Thin section examinations of two granitic rocks, one from the west end of the Pickle Lake pluton and the other northeast of First Loon Lake, showed well developed cataclastic textures. The metavolcanic-granite contacts, where examined by thin section almost universally display cataclastic features. A sample of albite trondhjemite on the metavolcanic-granite contact near First Loon Lake displayed strong cataclastic features; a second sample of quartz diorite from an appendage of the Pickle Lake Stock on the western margin displayed strong cataclastic features. A third sample of granodiorite collected from the north side of Dona Lake on the margin of the Ochig Lake Pluton displayed weak to moderate cataclastic features.

These samples contain quartz with wavy extinction and oblate porphyroblasts of plagioclase set in a matrix of granoblastic quartz and plagioclase. The micaceous minerals (biotite) are euhedral and define the foliation, however, the quartz and feldspars are allotriomorphic. Some of the larger plagioclase grains display bent twin lamellae and microfaulting. Texturally some of the rocks approach a protomylonite (Higgins 1971).

Cataclastic textures along the metavolcanic-granite contact have been described in the Kapkichi Lake area by Verbeek *et al.* (1972, p.139) as follows:

> Wall rocks: On both sides the orebody is bordered by amphibolites, which are typically schistose and well lineated. To the north of the sulphide zone, sills, and lenses of granite become abundant. Some of the large granite bands show cataclastic textures, and are locally converted to a crushed, foliated rock resembling a mylonite.

Thus, field and petrographic data suggest that the metavolcanic-granite contacts of the Pickle Lake belt are the locus of magmatic and tectonic activity.

Commencing from the time when gold mineralization was initially discovered on the present property of Central Patricia Gold Mines Limited in 1928, the Pickle Lake belt has been subjected to intense prospecting. This belt has received more exploration attention than any other within the limits of the present survey. Substantial gold production has been recorded. From 1935 until its closing in 1966, the Pickle Crow gold mine produced 44 982.28 kg (1 446 214 ounces) of gold and 5248.93 kg (168 757 ounces) of silver for a total value of $52 376 169 (Ferguson *et al.* 1971, p.202-203). During 1935 to 1951, the nearby Central Patricia gold mine produced a total of 1953.48 kg (62 806 ounces) of gold and 1814.86 kg (58 349 ounces) of silver for a value of $22 920 236 (Ferguson *et al.* 1971, p.200-202). A minor unspecified amount of scheelite was produced at the Pickle Crow mine during 1943 (Ferguson *et al.* 1971, p.203). There is little need to elaborate upon the early mineral exploration in the Pickle Lake belt as a wealth of information concerning these investigations is available in several geological reports of the former Ontario Department of Mines, and individual papers (Hurst 1930; Thompson 1939; Corking 1949; Marvin 1952; Pye 1956; Ferguson 1966).

Exploration for gold became desultory during the 1950s and 1960s mainly related to a fixed value for this metal. In 1971, a major copper-nickel discovery by Union Miniere Explorations and Mining Corporation Limited (UMEX) precipitated a large staking rush and revived interest in the economically depressed Pickle Lake area.

At least 10 000 claims were recorded in the Pickle Lake area following formal announcement of the UMEX discovery (The Northern Miner, June 3, 1971, p.1; July 1, 1971, p.1). This significant discovery was made early in the exploration program of UMEX and resulted in a very intensive, systematic search for additional mineralization within metavolcanic-metasedimentary belts confined largely to the southern half of the survey area.

Initial UMEX interest in the Pickle Lake belt centered upon examination of several small lenticular ultramafic-mafic bodies in the Kapkichi Lake area which contain uniform low-grade copper-nickel mineralization (see "Kapkichi Deposits"). As of late 1973, total diamond drilling by UMEX within the map-area had approached 15 000 m (E. Reeve, UMEX, personal communication).

Numerous other exploration companies, most notably Conwest Exploration Company Limited, Canadian Nickel Company Limited, Transterre Explorations Limited, and James Bay Mining Corporation Limited have additionally carried out exploration programs in the Pickle Lake belt (Assessment Files Research Office, Ontario Geological Survey, Toronto).

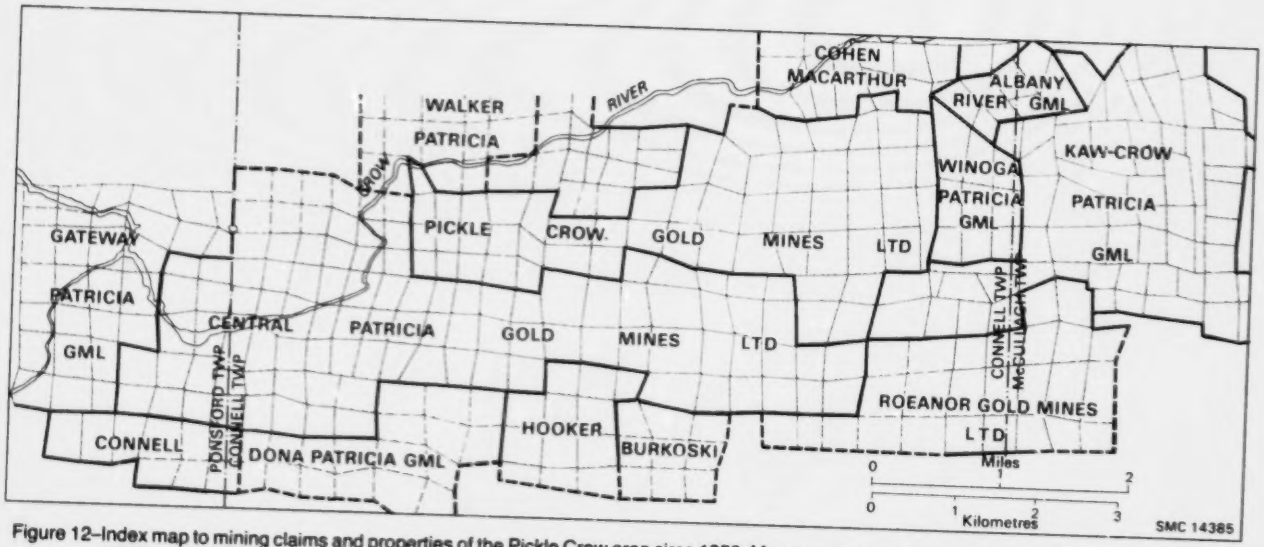


Figure 12–Index map to mining claims and properties of the Pickle Crow area circa 1950. Map accompanies report by Pye (1956). Data compiled from Thomson (1939), map 47b.

PROPERTY DESCRIPTIONS

Kapkichi Deposits

Several small mafic to ultramafic masses lying along and underneath Kapkichi Lake, 13 km due west of Central Patricia have received considerable exploration attention by various mining companies during the past 28 years. Copper-nickel mineralization in metagabbro was initially discovered here on claims PA7789 and PA7788 (presently claim PA15461) in the mid 1940s. During the period 1946 to 1950, Central Patricia Gold Mines Limited carried out ground magnetic surveys, trenching, and diamond drilling. Eighteen holes totalling at least 1263 m probed the original copper-nickel showing on claims PA7789 and PA7788 in addition to several magnetic anomalies in the immediate vicinity (Assessment Files Research Office, Ontario Geological Survey, Toronto).

From 1956 to 1958, Kapkichi Nickel Mines Limited continued investigations in the area, through magnetic-electromagnetic ground surveys, and eight diamond drill holes totalling 1405 m. This exploration program encountered a second mineralized copper-nickel body by diamond drilling on claims PA20875 and 20876, situated about 2600 m southwest of the original Central Patricia Gold Mines Limited showing.

In 1969, Union Miniere Explorations and Mining Corporation Limited optioned 12 patented claims from Kapkichi Nickel Mines Limited (The Northern Miner, June 22, 1972, p.19) and acquired additional ground through staking. Ground magnetic and electromagnetic (vertical loop) surveys, and 60 drill holes in 1970 outlined several additional ultramafic lenses containing low grade copper-nickel mineralization (T. Verbeek, UMEX, personal communication).

Geology and Mineralization. The original copper-nickel showing on claim PA15461 is contained within a small lensoidal, predominantly ultramafic body accompanied by local phases of metagabbro (private geological maps, UMEX and Figure 13). This unit intrudes massive to banded, locally pillowed amphibolitized mafic metavolcanics. Dimensions of this small stock average 580 m in length and 210 m in breadth. Chalcopyrite, pyrite and nickeliferous pyrrhotite, disseminated throughout a zone about 270 m long and 90 m wide, are apparently associated with the metagabbro phase. A representative core section 30 m in length averaged 0.50 percent copper and 0.25 percent nickel. Local sections (3 to 4.5 m) contained relatively high values of combined copper-nickel between 1.5 and 2.0 percent (Source Mineral Deposit Record, Geoscience Data Centre Files, Ontario Geological Survey, Toronto).

The copper-nickel mineralization discovered by Kapkichi Nickel Mines Limited in 1956 and later investigated by UMEX, occurs within a slender ultramafic raft (580 m by 60 m maximum surface dimensions) enclosed by a small granitic stock (Figure 13). Best intersection by Kapkichi Nickel Mines Limited

averaged 1.31 percent copper and 0.14 percent nickel over 6.1 m (Assessment Files Research Office, Ontario Geological Survey, Toronto).

A description of the geology and mineralization of the ultramafic bodies encountered by Union Miniere Explorations and Mining Corporation Limited was given by Verbeek (UMEX, personal communication):

> The lenses are of various shapes, attitudes, and sizes. The largest, which lies entirely under Kapkichi Lake, is a lens approximately 2,000 feet by 1,000 feet in area, up to 800 feet thick, and dipping gently to the north. It is quite uniformly mineralized, with grades of about 0.45% Cu, and 0.12% Ni. The other lenses carry closely similar grades of mineralization, although sections of lower grade are common, particularly in the smaller masses.
>
> The deposits consist of lenticular bodies of mineralized peridotite with minor gabbro, occurring in a series of amphibolites which probably represent altered basic volcanics, and are locally intruded by small masses of granite. None of the mineralized rocks are found in outcrop. They were found by diamond drilling of magnetic anomalies, some of which also gave an electromagnetic response.
>
> The peridotite-gabbro lenses are all mineralized to varying degrees, but most carry a rather homogeneous disseminated sulphide mineralization. The sulphides, in order of abundance, are: pyrrhotite, chalcopyrite, cubanite, and pentlandite. Magnetite is also present and a little pyrite is found in some altered rocks. Massive sulphides occur locally in veinlets a few inches thick, but do not contribute substantially to the overall grades of copper and nickel. Non-mineralized peridotite is rare, and the mineralization also very seldom extends outside the ultrabasic rocks, although granite veins cutting the mineralized peridotite commonly carry a little chalcopyrite for a few feet close to their margins.

While these deposits are not economically viable at present due to low grades and potential milling problems related to the very fine grain size of contained sulphides, a UMEX annual report for 1972 stated "that the exploration of the Thierry deposit would constitute an element in favour of the future development of these low grade ores". No tonnage figures had been released at the time of writing.

Union Miniere Explorations and Mining Corporation Limited — Thierry Copper-Nickel Deposit

No surface expression of the Thierry deposit was available for examination during the 1972 field season, as the immediate area is pervasively mantled by Pleistocene glacial till and fluvial materials averaging 4.5 m in thickness. Limited observations were made by the present survey, however, on sparse exposures both along the UMEX road, and on a small outcrop scraped clear by earth-moving equipment, approximately 90 m northwest of the shaft site. Additionally, some attention was given to the rock dislodged during shaft sinking operations, particularly that containing narrow veins of copper-nickel mineralization (see "Mineralization"). Thus, much of the following discussion is abstracted from Verbeek *et al.* (1972) and through personal communication with UMEX geologists, most notably C. Bowdidge and E. Reeve.

Location and Access. The Thierry copper-nickel deposit is located approximately 11 km west-northwest of Pickle Lake Landing. Specifically, this deposit is situated on claims PA263810, 263813, 263819, and 263820 of a 1500-claim

group of UMEX. A gravel road of 16 km length, which was completed in 1972, provides direct access from Highway 599 to the UMEX property.

History and Development. After the moderate success achieved in outlining extensive low grade copper-nickel mineralization along Kapkichi Lake during 1969 and 1970, a decision was made to embark on reconnaissance ground magnetic and electromagnetic surveys aimed at establishing whether this geological environment persisted to the north of Kapkichi Lake. A significant magnetic-electromagnetic anomaly was subsequently detected just south of Ponsford Lake. The initial hole "intersected 25 feet of black, fine-grained biotite schist, of which 20 feet were mineralized with grades of 1.24 percent copper and 0.14 percent nickel" (Verbeek *et al.* 1972, p.139). Subsequent diamond drilling (77 holes totalling 13 700 m) established ore grade mineralization along a strike length of 975 m to a vertical depth of 450 m (Verbeek *et al.* 1972). An estimated 11 million tonnes of potential ore had been delineated at the time of writing with an average grade of 1.68 percent copper and 0.18 percent nickel (C. Bowdidge, UMEX, personal communication).

Developments during 1973 and 1974 included completion of a head frame and three-compartment vertical shaft to a depth of 542 m with establishment of three drifts at 180, 360 and 480 m. Crosscutting has been undertaken on all three levels (C. Bowdidge, UMEX, personal communication). A total of 2890 m of lateral work and 15 850 m of underground drilling has been planned for the present developmental phase. Metallurgical tests by Lakefield Reserach Limited achieved a concentrate grading over 25 percent copper with a recovery exceeding 90 percent of the copper. A satisfactory concentration of nickel had not been achieved at the time of writing because of the extensive alteration of pentlandite to bornite (C. Bowdidge, UMEX, personal communication).

Regional Geology. The Thierry deposit occurs along the northwestern margin of the Pickle Lake metavolcanic-metasedimentary belt, about 2400 m due north of the Kapkichi Lake deposits (Figure 13, Chart B, back pocket).

Previous geological mapping by Dyer (1934) and Duffell *et al.* (1963) erroneously indicated the contact of the metavolcanics and the granitic batholithic complex to straddle the northern shoreline of Kapkichi Lake. Recent detailed mapping and diamond drill compilation by C. Bowdidge and E. Reeve more definitively extended the southwest to west-southwest trending contact of the Pickle Lake belt respectively to an unnamed lake 6 km northeast of Minominatik Lake and Ponsford Lake. This contact approaches within 270 m of the Thierry deposit.

More specifically, the deposit occurs within a narrow "corridor" of foliated amphibolitized mafic metavolcanics which extends for 10 km west from just above Hook Lake to southwest of Ponsford Lake. This "corridor" narrows to approximately 700 m in vicinity of the Thierry deposit. Granitic rocks of the Pickle Lake Stock and possibly of the Dobie Lake batholithic complex respectively bound the metavolcanic "corridor" to the south and north. *Lit-par-lit* in-

jection of granitic rock commonly occurs along this metavolcanic unit as revealed by diamond drilling in proximity to the Thierry deposit. Frequency of such injections increases markedly northwards from the deposit.

On a regional scale, several *en echelon* northeast trending photo-lineaments are apparent along Trebell and Kibler Lakes, along Ponsford Creek, and possibly along Tarp Lake. As glacial overburden is very widespread in the general area, these photo-lineaments may not be indicative of underlying bedrock control. One important structural feature revealed by the present survey is the prevalence of prominent cataclastic zones, along the periphery of metavolcanic-metasedimentary supracrustal sequences. These cataclastic zones are dominantly controlled by contact of these sequences with adjoining granitic batholithic complexes. This situation is well exemplified along the northern contact of the Meen-Dempster Lakes belt and appears to be a case in point at the Thierry deposit. The shear zone of the Thierry deposit (at 150 m level) trends approximately N60E degrees azimuth, subconcordant to the metavolcanic contact with dips inclined at about 60 degrees to the north. Significantly, Verbeek *et al.* (1972, p.139) have noted that "Some of the larger granite bands show cataclastic textures, and are locally converted to a crushed, foliated rock resembling a mylonite."

Geology of the Thierry Deposit. A geological plan of the 150 m level interpreted from surface diamond drilling is shown in Figure 14. The mineralization is largely confined to a major shear zone, consisting dominantly of very fine-grained biotite-chlorite-hornblende ultramafic schists. The above three minerals are modally variable and generally the rock contains meager plagioclase. The grain size is usually less than 1 mm.

To a lesser extent, mineralization occurs within associated, relatively less intensely deformed, altered lenses of peridotite and gabbro, distributed along the foot wall.

The largest such mass is about 240 m in length and 120 m in breadth, described by Verbeek *et al.* (1972, p.139) as "a tremolite-chlorite rock with diablastic texture, carrying abundant magnetite, a little ilmenite, and local traces of sulphides, mainly pyrrhotite." A smaller ultramafic body occurs at the west end of the mineralized shear zone "varying from light green tremolite-chlorite rock to darker green actinolite rock, which grades into metagabbro, consisting of hornblende and plagioclase with blastophitic texture" (Verbeek *et al.*, 1972).

The shear zone is apparently conformable to well foliated to schistose and lineated amphibolitic mafic metavolcanic wall rocks. Examination of the small scraped outcrop northwest of the shaft disclosed the subtle presence of deformed pillow structures within fine-grained to medium-grained light blue-green (weathered surface) amphibolitized mafic metavolcanics. Selvedges up to 5 mm in thickness appear somewhat darker on weathered surfaces being mainly composed of hornblende and biotite, slightly coarser-grained than the pillow interiors.

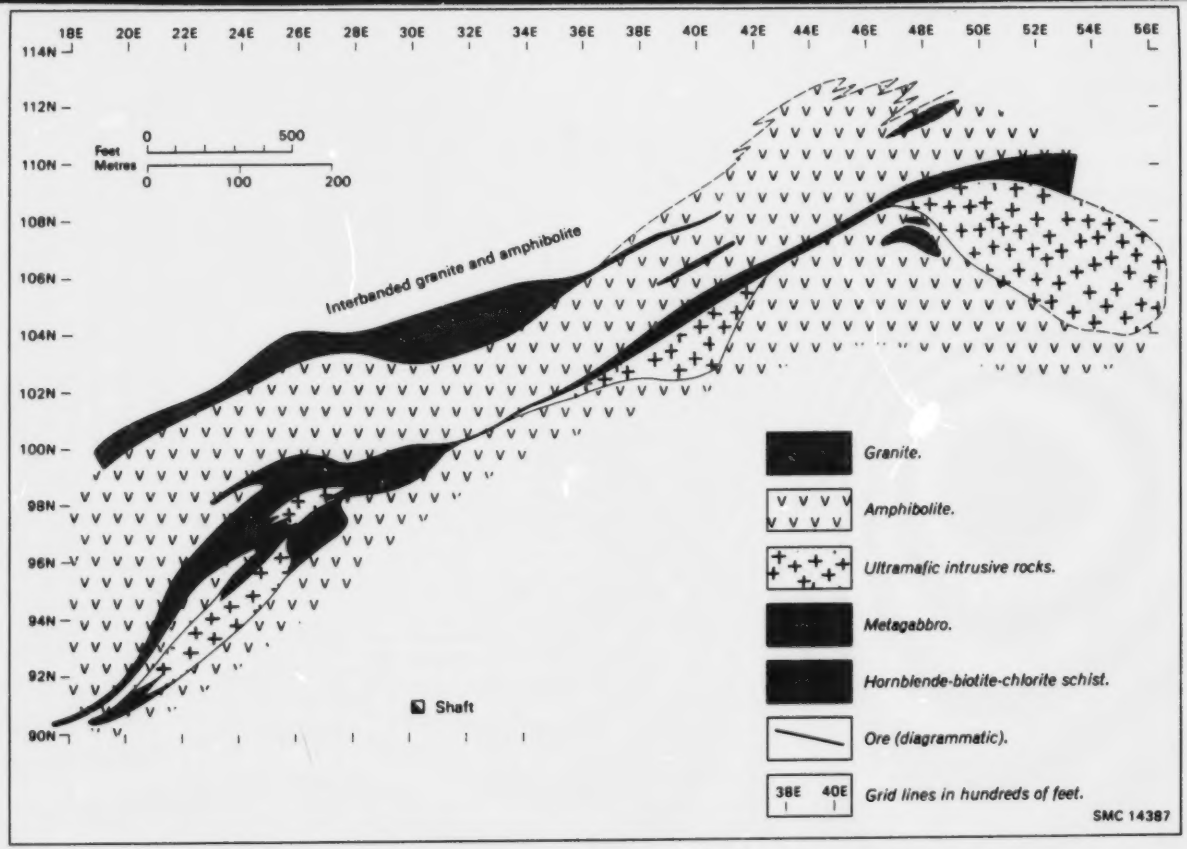


Figure 14–Geological plan at the 150 m level as inferred from diamond drilling. From Verbeek *et al.* (1972).

Mineralization. Near the surface the Thierry deposit is composed of one continuous mineralized zone, approximately 980 m in length and varying up to 30 m in width. The mineralized zone, at the time of writing, was open at depth along most of its length as surface diamond drilling penetrated to about 240 m and to 450 m along one section (C. Bowdidge, UMEX, personal communication). Below 150 m between sections 30E and 36E, the deposit becomes segmented into two zones of roughly equal extent, and somewhat different mineralized character. The northeastern part is a biotite-chlorite-hornblende schist with the sulphides occurring as tiny concordant stringers. In the southwestern segment the ultramafic rocks, in general, are less schistose with the sulphides concentrated in massive stringers separated by disseminated or barren zones (C. Bowdidge, UMEX, personal communication).

The primary sulphide minerals, listed in order of approximate decreasing abundance, are pyrrhotite, chalcopyrite, pyrite, and pentlandite. Both violarite and mackinawite have developed as alteration products of the pentlandite. Smythite and millerite respectively occur as inclusions in pyrrhotite and as fine lamellae in chalcopyrite. Magnetite and minor ilmenite are additionally present. Combined volume of sulphide and oxide minerals comprises about 15 percent of the rock. A crosscut on the 180 m level intersected a zone of disseminated bornite in amphibolite (C. Bowdidge, UMEX, personal communication). The initial underground development work indicated a substantially higher grade of mineralization than indicated by the diamond drilling program (C. Bowdidge, UMEX, personal communication).

Additional significant mineralization is contained within the flanking, relatively undeformed ultramafic lenses, particularly at the western end of the main mineralized zone. Sulphides principally occur in this situation as irregular masses and blebs, also averaging approximately 15 percent by volume of the rock.

Origin of Thierry Deposit. The most plausible explanation advanced to date, concerning origin of this deposit, involves a tectonic-metamorphic mobilization mechanism and concomitant concentration of pre-existing copper-nickel sulphides into a shear system. Several observations lend support to this interpretation:

(1) an abundance of ultramafic-mafic masses containing low grade disseminated copper-nickel mineralization both contiguous to the Thierry deposit as well as in the local area (Kapkichi deposits);
(2) if all the copper-nickel were redistributed into the combined mass of ultramafic and mafic rocks contiguous to the deposit, the original calculated grades would have been 0.56 percent copper and 0.13 percent nickel. These grades are comparable to other ultramafic-mafic mineralized bodies in the area (Kapkichi deposits); and,
(3) the average copper/nickel ratio (weight percent) calculated on each section expresses a progressive increase within the shear zone in a northeast to southwest direction (Figure 15).

The latter observation supports the notion of a preferential lateral migration of copper with respect to nickel, assuming the relatively large ultramafic

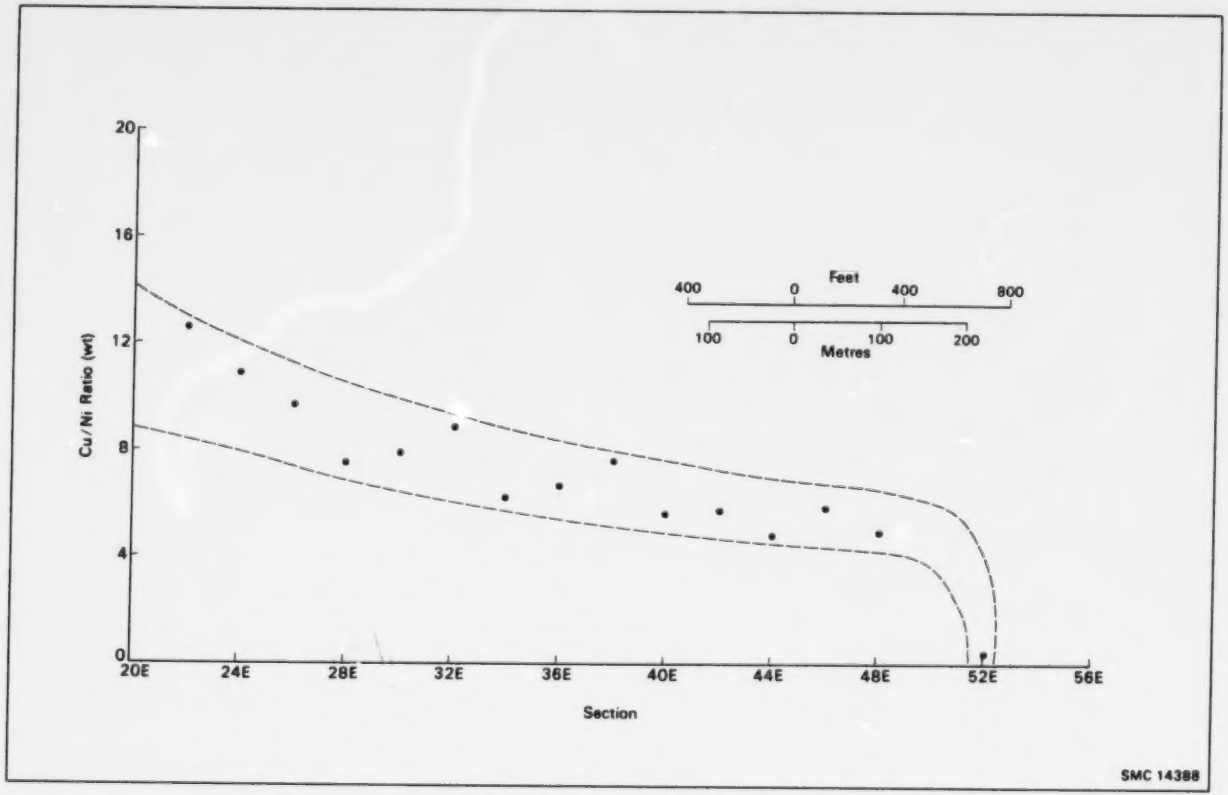


Figure 15–Variation in copper/nickel ratios along the Thierry deposit, based on average analyses of core from diamond drilling on each section (from Verbeek *et al.* 1972, p.143).

mass at the northeast end of the mineralized zone represents original source of these metals.

Some evidence indicating that solid-state mobilization mechanisms and differential movement of sulphide minerals occurred is expressed in a preferential concentration of pyrrhotite relative to chalcopyrite into crests of minor Z-type folds noted in rock excavated from the UMEX shaft site. The relative importance of such a mechanism in transporting and concentrating ore metals and/or minerals in comparison to solution transport via hydrothermal fluids developed during amphibolite facies regional metamorphism is an important matter to be reconciled by future detailed underground mapping and metal distribution studies.

Present Survey Investigations. In July of 1972, the UMEX shaft site was visited by several members of the present survey. The shaft is situated about 240 m south of the mineralized zone along section 30E (see Figure 14). Previously unknown marcasite-chalcopyrite-pyrite mineralization was apparent in some of the rock waste piles displaced during the early shaft sinking operations at this time. This mineralization principally occurs in narrow veins up to 2 cm wide largely concordant to host rock foliations and accompanied by quartz and amphibolite fragments. An abrupt contact with the fine-grained, jet-black (fresh surface) strongly foliated, amphibolitized mafic metavolcanics is usually apparent. Foliation within the amphibolite appears in part defined by platy orientation of diminutive, megascopic hornblende prisms, which achieve a maximum length of 5 mm. On foliation surfaces, these prisms display a random orientation of the C-axis, and impart a glittering effect to the rock in reflected light.

A distinctive dark grey (fresh surface) possible alteration zone, 7-8 cm wide often envelops the mineralized veins. Numerous circular to ellipsoidal grey spots up to 3 mm in diameter characterize this zone and tend to coalesce near the veins. These spots may be related to alteration activity (porphyroblasts) or represent relict variolites.

Z-type minor fold structures were evident in some samples at the shaft site, rendered conspicuous by a mobilization of sulphides, particularly marcasite into the fold noses and an attendant tapering of the veins outward along the flanks.

The mineralized veins contain masses and patchy disseminations of marcasite and chalcopyrite comprising up to 50 percent of a given short section. Although marcasite generally predominates, lateral variation within a single vein often determines the dominant sulphide. Marcasite occurs as rounded, concentric, onion-structured nodules of extremely fine-grain size. A more closely crystalline second generation of marcasite occurs around the rims of these nodules and within fissures. Chalcopyrite is usually present in close association with marcasite. Also several thin fractures, 1 to 4 mm in width, were occasionally observed to traverse outwards at low angles into the host material from the chalcopyrite dominant sections of the larger veins. Sparse disseminated pyrite grains up to 1 mm in diameter are common within the host rock.

Three grab samples of the vein material were submitted for assay to Geoscience Laboratories, Ontario Geological Survey. Results are given in Table 10.

TABLE 10 | ASSAYS OF MINERALIZED GRAB SAMPLES FROM THE UMEX SHAFT SITE, THIERRY DEPOSIT.

Sample Number	Copper[1]	Nickel[1]	Gold[2]	Silver[2]	Palladium[2] Group Metals	Platinum[2] Group Metals
DD3–1	2.08	0.25	0.01	0.62	0.30	0.07
DD3–2	1.98	0.16	0.02	0.62	0.26	0.04
DD3–3	2.04	0.22	0.01	0.80	0.22	0.03

Assays by Geoscience Laboratories, Ontario Geological Survey.
1. In weight percent
2. In ounces per ton

The assays have significantly revealed important quantities of palladium and platinum group metals as well as silver to be present. Although relationship of the described mineralization at the UMEX shaft site to that within the main zone is presently uncertain, platinum values have interestingly been recorded in one of the recent crosscuts by UMEX. A value of 0.26 ounces platinum per ton was obtained on a specimen of massive chalcopyrite (C. Bowdidge, UMEX, personal communication).

Spectrographic analysis of the heavy mineral fraction additionally revealed a small quantity of tellurium. In polished section, several minute unidentified grains were observed within chalcopyrite. These grains, which varied in diameter from 20 to 50 micrometres, were weakly birefringent and slightly harder than chalcopyrite but softer than marcasite and pyrite. The mineral could not be identified. The small birefringent grains coupled with the detected presence of tellurium and palladium suggest the possibility of temagamite (Pd_3HgTe_3) or some related mineral.

Radiating clusters of light brownish stilbite interestingly occur as fracture controlled fillings on a few specimens of medium-grained grey (fresh surface) "speckled" amphibolite unearthed from the shaft. This mineral, which, was verified by X-ray diffractometry, was observed to occur along two fracture planes intersecting at approximately 50 degrees. This appears to represent one of the few recorded occurrences of zeolite group minerals within Early Precambrian metavolcanics in northwestern Ontario.

RECOMMENDATIONS FOR FUTURE EXPLORATION

Bearing in mind the relationship between metavolcanic belt-granitic batholith contacts and major zones of cataclasis apparent over widespread areas in the present survey, it is suggested that additional mineralization similar to that of the Thierry deposit may exist elsewhere in the map-area. Exploration programs should carefully examine geologically all peripheral zones of the su-

pracrustal belts for presence of ultramafic-mafic lenses and superimposed prominent shear systems. This recommendation may apply to other volcanic-rich subprovinces of the Superior Province as well.

The relatively extensive felsic to intermediate metavolcanic sequence in the Pickle Crow mine area warrants obvious exploration attention from the standpoint of volcanogenic base metal mineralization. Although the northern half of this unit is largely covered by patented gold claims (area of Pickle Crow, Claim Map, Plan 3193, Ontario Geological Survey, Toronto), a substantial part of the sequence, mainly in Connell Township, remains open ground and clearly deserves exploration consideration.

LAKE ST. JOSEPH BELT

Eastern and western sections of the Lake St. Joseph belt lie within the map-area. This metavolcanic-metasedimentary belt segment is approximately 50 km long and has a width varying from 10 km to 1 km within the map-area. The density of outcrop is substantially greater along the eastern section of the lake in comparison to the central area. Towards the western extremity of the belt prominent exposures occur in the vicinity of Johnston Bay. Access to the lake is gained by Highway 599 at the east end of the lake where a boat ramp is present on Doghole Bay.

The eastern half of the Lake St. Joseph area was mapped fairly recently by Goodwin (1965) and the western half by Clifford (1969). For a more detailed account of the geology of this belt the reader should refer to these reports. Prior to the detailed work, the Lake St. Joseph area was covered by a regional reconnaissance geological mapping program of the Geological Survey of Canada (Emslie 1960). E.L. Bruce (1923) carried out a geological mapping survey which included the east half of Lake St. Joseph and gave a general outline of the extent of the Lake St. Joseph belt.

The belt comprises metasediments dominantly of greywacke composition but including notable thicknesses of iron formation, felsic to intermediate metavolcanics and pyroclastics, mafic to intermediate metavolcanics, and mafic intrusions. Younger granitic stocks intrude this assemblage east of Soules Bay.

A centrally located unit of metasediments is flanked to the north and south by mafic and felsic metavolcanics. The greatest width of the belt within the map-area is in the vicinity of Soules Bay. Westward of Soules Bay the belt arches around and encloses the Doran Lake granitic stock, and only the northern segment of the belt marginal to the stock is within the map-area.

To the north of the belt lies the Carling granitic batholithic complex which encompasses most of the eastern and northern portions of the Lake St. Joseph area. Within the granitic terrain extensive drift cover prevails, with prominent drift ridges and southwest trending eskers. These ridges to a large degree control the shape of the shoreline of Lake St. Joseph.

Oolitic hematite-magnetite iron formation boulders, distinctly different from the banded chert-magnetite (Algoman type) and magnetite-greywacke type characteristic of Soules Bay, are locally found along the shoreline of Lake St. Joseph. These boulders are probably derived by glacial erosion of an unknown source area possibly located in the Hudson Bay Lowland.

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics are located north and south of the major metasedimentary unit which passes through Soules Bay. These metavolcanics continue eastward beyond Ace Lake and merge with the metavolcanics of the Pashkokogan Lake-Misehkow River belt. A mafic to intermediate metavolcanic unit is indicated by exposures on several islands in east-central Lake St. Joseph and another smaller unit occurs at Brodribb Bay just north of the Doran Lake stock. These metavolcanic units are dark grey to greenish grey on weathered surfaces and generally dark grey on fresh surfaces. They are variously massive to foliated and are pillowed. Only three shoreline exposures were observed to have pillow structures. The pillows were elongated and thus unreliable for stratigraphic top determinations.

The mafic to intermediate metavolcanics are generally composed of fine- to medium-grained hornblende and plagioclase in roughly equal proportions, and locally mineral segregation or banding is apparent. Porphyritic varieties are present locally and one such occurrence is on a small island adjacent to the north margin of the Doran Lake stock. Here a mafic to intermediate metavolcanic unit displays an abundance of medium- to coarse-grained, euhedral to subhedral plagioclase phenocrysts which appear slightly oriented parallel to the strike of the unit.

In general, the shoreline exposures of the mafic to intermediate metavolcanics are not as numerous as those of the metasediments and the felsic to intermediate metavolcanics.

FELSIC TO INTERMEDIATE METAVOLCANICS

Felsic to intermediate metavolcanics are dominantly pyroclastic and are best exposed along the north shore of Soules Bay and in the vicinity of the major island north of this bay (Sage *et al.* 1973d). Good exposures are also present on the south shore of Lake St. Joseph west of Soules Bay and just north of the Doran Lake Stock.

In the Soules Bay area the pyroclastic rocks consist of an interlayered sequence of felsic to intermediate agglomeratic deposits and intermediate tuffs. Locally the pyroclastic rocks have a mafic matrix. The agglomerates generally have whitish-grey weathered lens-shaped fragments of apparent intermediate (dacitic) composition embedded in a well foliated often more mafic matrix of fine-grained hornblende and plagioclase with local minor concentrations of medium-grained garnet. The contrast in composition between the matrix and enclosed fragments is often visually striking. Elsewhere, the lensoid bomb and lapilli sized fragments are found within a felsic to intermediate tuffaceous matrix of fine-grained, recrystallized quartz, biotite and feldspar. Included within the matrix are subangular to subrounded, fine to medium grained whit-

ish, recrystallized felsic lithic fragments. Some pyroclastic outcrops have a discontinuous lensoid to almost banded appearance reflecting highly stretched breccia fragments within a more foliated mafic matrix. Interlayers of intermediate tuff of probable dacitic composition display well developed banding which is interpreted as primary bedding.

In contrast to the coarse pyroclastic deposits found in the Soules Bay area, the pyroclastic deposits further west along the lake and north of the Doran Lake stock are predominantly of finer-grained tuff. These tuffaceous deposits consist of an assembalge of felsic, intermediate, and mafic tuff and lapilli-tuff, interlayered with agglomeratic units. A felsic tuff unit is found on the peninsula north of the Doran Lake stock which contains lensoid mafic fragments averaging 60 by 10 cm. These mafic fragments are medium-grained, hornblende rich and constitute about 40 percent of the exposure. This unit contrasts with the general nature of the mixed pyroclastic deposits of the Soules Bay area where dacitic fragments are commonly observed within a more mafic matrix. At three separate locations, outcrops of felsic metavolcanic flow units were noted near the north rim of the Doran Lake stock. These flow units were not mapped as such by Goodwin and their presence suggests at least a slightly greater thickness of the belt at this point. The felsic metavolcanic flow units are characterized by a whitish weathered surface, fine-grained to aphanitic texture, poorly developed foliation, and rounded medium- to fine-grained quartz and feldspar phenocrysts. A clearer definition of the stratigraphy north of the Doran Lake stock is inhibited by overburden cover.

METASEDIMENTS

A major metasedimentary unit in the vicinity of Soules Bay strikes east to Ace Lake and westward along the south margin of the Doran Lake stock. The assemblage is predominantly greywacke (Goodwin 1965). The most common metasediment is feldspar-biotite-quartz schist, frequently bearing metacrysts of staurolite and/or andalusite ± garnet. The more argillaceous bands are now marked by the greater concentration of aluminous metacrysts.

Massive, homogeneous and graded greywacke units are interbedded. Amongst the most spectacularly exposed metasedimentary units is the thick bedded greywacke in Soules Bay. The Soules Bay metasediments contain large metacrysts of andalusite (up to 5-7.5 cm in length) and staurolite (up to 2.5 cm in length) within the upper argillaceous portion of the units. The lower arenaceous portion of each bed is composed essentially of plagioclase, biotite and quartz. The argillaceous portions of the beds vary from 5 to 75 cm in thickness and average approximately 45 cm. The arenaceous portion varies from 5 to 30 cm in thickness and averages approximately 13 cm. Graded bedding is distinct with the visual effect of reverse metamorphic grading indicated by the presence of large metacrysts in the argillaceous part of each bed. These thick bedded units represent a fairly uniform sequence of interbedded sandstone-argillite couplets characteristic of turbidite deposits.

Pebble conglomerate units west of Soules Bay and somewhat marginally to the Doran Lake stock have been described by Goodwin (1965). In this area

poorly sorted conglomerate horizons are interlayered with gritty subarkose to arkose. The arkosic interbeds contain granules and small pebbles (up to 7 mm diameter) of predominantly orthoquartzite. The conglomeratic units were observed to vary in thickness from 20 to 45 cm and the feldspathic sandstone interbands from 31 to 48 cm. Greater thicknesses were reported by Goodwin (1965). Goodwin's (1965) observation of relative pebble abundances was confirmed. In order of decreasing abundance the pebbles are orthoquartzite, iron formation, vein quartz, grey granite, and greenstone.

The pebbles are generally angular to subrounded; the iron formation and greenstone pebbles are typically elliptical and all others are subspherical. The pebbles range in size from 6 mm to 10 cm and all types occur in the complete size range. Pebble alignment often accentuates the schistosity which is often oblique to the bedding.

IRON FORMATION

Iron formation is interbedded with greywacke schist composed of plagioclase, biotite, quartz, ±staurolite, ±garnet, ±andalusite. The magnetite-quartz (recrystallized chert) bands are characteristically of equal width or thinner than the associated clastic sediments. The authors are in agreement with Goodwin's (1965) observation of a general increase in the width and number of iron-bearing bands relative to schist bands in the vicinity of Soules Bay.

The magnetite-chert and sedimentary bands are locally complexly folded. The individual magnetite-chert bands in places bifurcate, pinch and swell, or become discontinuous along strike. The magnetite-chert bands are thinly laminated and were observed to vary from between 8 mm to 35 cm in thickness. The greywacke beds may or may not exhibit grain gradation and may reach a thickness of 40 cm. Goodwin (1965) has noted a cyclic characteristic of the magnetite-chert and sedimentary beds. From the bottom to the top of a magnetite-chert and sedimentary couplet, brown coarser grained clastic material commonly grades into finer grained clastic material capped by a black thinly laminated layer of magnetite-chert which grades into white thinly laminated chert. This cycle is then repeated in the next magnetite-chert and sediment couplet. In these rhythmic sedimentary accumulations this feature can locally be used for the determination of stratigraphic tops. Goodwin (1965) noted that the mutual association of iron-rich and alumina-rich sediments indicates a common source. Goodwin (1965) also postulated that the source for the iron and silica was related to a phase of volcanism.

The presence of pebble conglomerate units with stratigraphic thicknesses which appear to thin east and west from Soules Bay (Goodwin 1965) and the decrease in clast size within the felsic pyroclastic rocks in the same general direction would suggest that the metasediments and metavolcanics of Soules Bay are proximal to the source. Goodwin (1965) indicated that the thickest and richest portion of the iron formation occurs in the immediate vicinity of Soules Bay, thus the iron formation is also most likely proximal to the source area. Therefore, the iron formation of Soules Bay, Lake St. Joseph, appears to have originated from a complex interplay of volcanism, erosion, and sedimentation.

MAFIC INTRUSIVE ROCKS

Gabbroic and dioritic intrusive bodies have been observed at three principal localities. On the northeast shoreline entrance to Soules Bay, the previously mapped mafic to intermediate metavolcanics (Goodwin 1965) are re-interpreted as a metadiorite to metagabbro body which has been concordantly emplaced within the sedimentary sequence. A homogeneous, massive, generally medium-grained texture is evident over a width of 0.8 km. The mafic body is composed mainly of diorite in which plagioclase of andesine composition often prevails over the mafic mineral content.

Approximately 2.4 km west of Ace Lake, and on the shore of Lake St. Joseph, metagabbro outcrops along the shoreline and on two small islands in the lake. These latter outcrops also lie within the major metasedimentary zone. The gabbro-diorite is massive, coarse-grained, and has apparently assimilated some iron formation and associated sediments as suggested by the local occurrence of enclosed discontinuous rusty schist and magnetite-bearing bands. The two mafic bodies are probably spatially related as both appear to have intruded the sedimentary zone at the same stratigraphic position. Evidence for a clearly intrusive relationship with the metasediments is generally lacking.

A third mafic intrusion is found on several islands southeast of Carling Island. This body is metadiorite, massive to foliated, medium grained, consisting of hornblende and plagioclase with some biotite and chlorite. Wispy to angular mafic inclusions occur within the diorite. This small mafic body is located on the margin of the Lake St. Joseph metavolcanic belt and the Carling batholith.

An intrusive body previously mapped as metadiorite (Clifford 1969) occurs on an island south of Carling Island. This body was found to be composed of angular blocks of diorite ranging from 10 to 70 percent of the exposed outcrop surface, set within a granodiorite matrix. As evidenced by the diffuse xenolith-granite boundaries, some of the larger xenoliths appear to be highly assimilated by the granodiorite. This outcrop has also been intruded by pegmatite dikes.

Just north of the Doran Lake stock isolated gabbroic outcrops occur among the exposures of mafic metavolcanics.

METAMORPHISM

The presence of staurolite in various metasedimentary assemblages indicates that the metamorphic rank is at least lower amphibolite facies of regional metamorphism (Turner and Verhoogen 1960). A typical specimen of the metasedimentary schist is composed of quartz + biotite + plagioclase (oligoclase to andesine) ± staurolite ± garnet ± andalusite. The presence of andalusite within the metasedimentary zone substantiates the conclusion of lower amphibolite facies of regional metamorphism and implies low pressure conditions of metamorphism. This observation may indicate that a contact metamorphic overprint of the established regional metamorphism has occurred which is related to the emplacement of several granitic stocks and in particular the Doran Lake stock.

A more detailed study of the metasediments in the vicinity of the Doran Lake stock would provide a clearer understanding of the structural and metamorphic effect that the stock has had upon the belt and relate the emplacement of the stock to the overall tectonic history of the area.

Structural Geology

The comparatively brief period spent in checking the eastern Lake St. Joseph area could only confirm the basic conclusions reached by Goodwin (1965). Goodwin indicated a major anticlinal axis trending southwestward through the major sedimentary zone and is particularly evident in the Soules Bay area. The anticline is overturned to the north and is identified by the orientations revealed in graded beds in metasediments and by the parasitic fold styles across the axis of the major fold.

No major fault structures were observed by the present survey or by Goodwin (1965).

The intrusion of the Doran Lake stock appears to have caused significant flexing of the belt around the margins of the stock. A felsic volcanic flow which can be used as a marker horizon indicates a curvilinear arc in the metavolcanic-metasedimentary stratigraphy along the north margin of the stock.

Economic Geology

Previous to 1956, very little economic interest was witnessed in the Lake St. Joseph belt. The geological survey of Bruce (1923) indicated several outcrops of magnetite-greywacke iron formation along the southeastern shoreline of Lake St. Joseph (Soules Bay area). No sulphide occurrences of any significance were encountered by the present survey.

PROPERTY DESCRIPTIONS

Steep Rock Iron Mines Limited, Soules Bay Iron Prospect

No apparent interest manifested in the Soules Bay area until 1956 when Charles K. Hansen, a prospector, staked 48 claims over two outcrops of iron formation (Taylor *et al.* 1972, p.101; Goodwin 1965, p.40). An option agreement for the property was finalized late in the same year, by Steep Rock Iron Mines Limited. Major economic interest involving extensive exploration, development and various feasibility studies proceeded over the period from 1956 to 1971 through airborne and ground magnetometer surveys, geological surveys, bulk sampling and diamond drilling (10 122 m). The latter part of this period was dominated by metallurgical, engineering, and market feasibility studies

TABLE 11 POTENTIAL ORE AT SOULES BAY IRON PROSPECT OF STEEP ROCK MINES LIMITED WITHIN PRELIMINARY OPEN PIT DESIGNS (MODIFIED AFTER TAYLOR *ET AL.* 1972.)

Ore Zone	Ore In Long Tons	Crude Soluble Fe Percent	Percent Weight Recovery	Stripping in Cubic Yards	
				Wallrock	Overburden
North Zone above 700 feet	342,607,000	23.78	30.5	18,839,700	10,390,300
North Zone between 400 feet and 700 feet	65,059,000	presently unknown	presently unknown		
South Zone	275,608,000	22.19	27.9	10,294,000	7,040,000
Total	683,274,000			29,133,700	17,430,300

(Taylor *et al.* 1972). A comprehensive, detailed geological discussion of this iron deposit is available in Goodwin (1965, p.40-54). The calculated ore reserves (Table 11) given by Taylor *et al.* (1972) are slightly higher than an earlier estimation given by Goodwin (1965, p.49). The revised figure of 694 238 000 tonnes (683 274 000 long tons) involves an addition of 66 103 000 tonnes (65 059 000 long tons) of unspecified average grade situated between the 120 m and 210 m levels (above sea level) within North Ore Zone.

Developments of metallurgical and engineering interest undertaken subsequent to publication of Goodwin's report are well summarized by Taylor *et al.* (1972, p. 99-116), and are beyond the scope of this report.

During 1970, exploration for volcanogenic massive sulphide deposits was undertaken in the Johnston Bay area, where the Lake St. Joseph belt merges with the Johnston Bay-Fry Lake belt. Cominco Limited sank two diamond drill holes totalling 182 m (Assessment Files Research Office, Ontario Geological Survey, Toronto). Cochenour Willans Gold Mines Limited investigated several electromagnetic conductors and sank four diamond drill holes totalling 104 m (Assessment Files Research Office, Geological Survey, Toronto). No economically significant mineralization was intersected by either exploration company.

RECOMMENDATIONS FOR FUTURE EXPLORATION

The present survey definitely established a greater volume of felsic to intermediate metavolcanics in the Broadribb Bay area than was previously realized. The total extent of a 25 km long east to northeast trending felsic metavolcanic unit was not completely established, as a significant portion likely extends south of Latitude 51°00', the map-area boundary. This large unit

would appear to be of a particular economic interest owing to paucity of previously recorded mineral exploration in the general area for metals other than iron.

OSNABURGH-PICKLE LAKES BELT

The Osnaburgh-Pickle Lakes belt merges to the south with the Lake St. Joseph belt and Pashkokogan Lake-Misehkow River belt. To the north the belt merges with the Pickle Lake belt and to the west it merges with the Dempster-Pickle Lakes belt. Only rarely does the outcrop density approach or exceed one percent of the surface area. The best exposures occur along the shores of Jean, Keating, and Osnaburgh Lakes, and Lake St. Joseph. Road cuts along Highway 599 offer a number of interesting outcrops for examination.

The Osnaburgh-Pickle Lakes belt rarely exceeds 1.5 km in width and consists almost exclusively of amphibolitized, pillowed mafic metavolcanics. Minor amounts of tuff are present and an interesting exposure of a volcanic breccia unit occurs along Highway 599, 128 km north of Savant Lake. Small, thin felsic metavolcanic units are locally present and thin metasedimentary units are commonly intercalated within the volcanic rocks. In the Lake St. Joseph area metasediments of greywacke, arkosic, and argillaceous composition are sufficiently abundant to form a mappable unit. Structural data is insufficient to make a meaningful structural interpretation for the belt. Previous mapping on the Osnaburgh-Pickle Lakes belt was completed by Goodwin (1965) in the eastern Lake St. Joseph area.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

The dominant rock type of the Osnaburgh-Pickle Lakes belt is mafic to intermediate metavolcanics. These metavolcanics are generally pillowed and foliated, with massive, brecciated, and tuffaceous varieties also present. It is estimated that the individual flow units are on the order of 30 m in thickness. The pillowed metavolcanics are generally so highly deformed as to make stratigraphic-structural interpretations from the shapes of the pillows impossible. In exposures along Highway 599 some pillowed metavolcanics are so highly attenuated that the selvages appear like bedding or banding in outcrop. Clifford (1969, p.19) in describing the western Lake St. Joseph area also mentioned difficulty in recognizing some pillowed metavolcanics because of intense flattening of the pillow structures. The pillows generally vary from 0.15 to 0.6 m in long dimension. The mafic metavolcanics have been regionally metamorphosed to the upper greenschist or middle amphibolite facies.

The mafic metavolcanics of the Osnaburgh-Pickle Lakes belt generally weather grey to green to black and on fresh surfaces are green to black. The

OGS 10 273

Photo 16–Isolated pillow breccia at Osnaburgh House, east end of Lake St. Joseph, Osnaburgh-Pickle Lakes belt.

darker colours generally reflect a higher metamorphic grade. In thin section the amphibolites are generally composed of a fine-grained mosaic of hornblende and untwinned to weakly twinned plagioclase in roughly equal proportions. Biotite and opaques may constitute up to five percent of the rock and minor amounts of epidote, quartz, and carbonate have been noted. The greenschist rocks are composed of predominantly actinolite, chlorite, and epidote in varying proportions. Minor to trace amounts of sericite, opaques, carbonate, biotite, and garnet were also observed. The greenschist rocks are found where the Osnaburgh-Pickle Lakes belt widens and joins the Lake St. Joseph belt, the Pashkokogan Lake-Misehkow River belt to the south and the Pickle Lake belt to the north. The amphibolitic rocks are generally found along the margins of the belts or where the belts are relatively narrow.

At the site of the former Hudson's Bay Company Limited's Osnaburgh House trading post on the northeast arm of Lake St. Joseph is an excellent exposure of isolated pillow breccia (Photo 16) which appears similar to those described by Carlisle (1963) from Quadra Island, British Columbia. The outcrop has isolated pillows up to 0.6 m in length in a breccia composed in part of fragmented pillows. In the same general area mafic metavolcanic breccias were observed to contain large (0.3 m) isolated spherical to oblate fine-grained felsic masses tentatively classified as felsic bombs. The felsic masses appear to be saussuritized inclusions within the mafic metavolcanics.

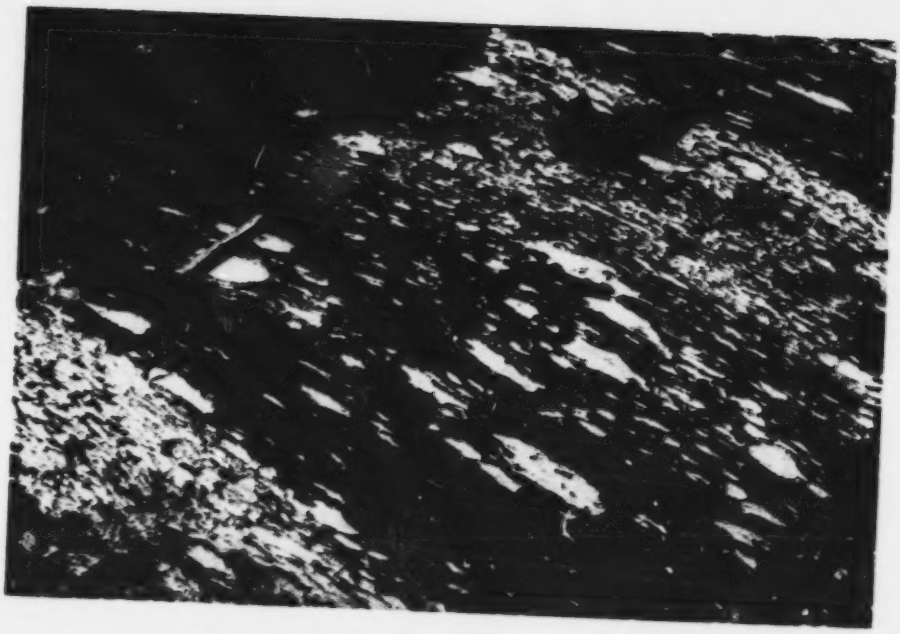


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Photo 17–Felsic clasts in amphibolite matrix. Note size and density variations in clast population. Exposure along Highway 599 approximately 130 km north of Savant Lake.

In a road cut on Highway 599 on the north side of Rat Rapids, well bedded mafic tuff and ash are associated with recrystallized cherty iron formation or quartzite and massive mafic metavolcanics. The individual beds are up to several centimetres in width and weather brownish black.

One of the more interesting occurrences of mafic metavolcanics is the breccia unit exposed along Highway 599, 130 km north of Savant Lake (Photo 17). This exposure is located just over 1.5 km north of the channel between Lake St. Joseph and Osnaburgh Lake and is particularly interesting since it consists of felsic fragments in a mafic matrix composed predominantly of hornblende with minor biotite in a number of distinct beds.

The breccia unit is enclosed within pillowed mafic metavolcanics and the spatial distribution of outcrop suggests that the unit probably exceeds 30 m in thickness. The rock in outcrop displays highly attenuated fragments whose length to width ratio is 9:1 or greater. The original shape of the fragments has been obliterated by subsequent deformation, but fragments rarely exceed 12 cm in length and generally average 5-8 cm in length. Elongation is parallel to the foliation and the fragments have also been considerably elongated in the plane of the foliation, plunging 75 degrees to the southeast. The fragments are not evenly distributed throughout the unit but are concentrated into beds gen-

erally 0.9 to 1.2 m in width which display a slight internal gradation in clast size. It was observed that a portion of a bed composed predominantly of felsic fragments and minor mafic matrix which in places grades across the bedding direction into a thicker more mafic rich portion where the felsic fragments are fewer but often somewhat larger (see Photo 17). Most commonly the individual beds have sharp contacts with each other and the width of individual beds varies slightly along strike. The fragment-rich to fragment-poor cycle is not complete in places.

The fragments are fine grained and generally of uniform composition with some variation in hornblende content. The fragments microscopically are seen to consist of a fine-grained mosaic of quartz and untwinned plagioclase. The matrix is medium to coarse grained and is visually estimated to be composed of 40-50 percent hornblende, 15-20 percent biotite, 15-20 percent fine-grained quartz and untwinned plagioclase, 5-10 percent epidote, 5-10 percent chlorite with minor carbonate and magnetite.

It appears that the unit may be of mixed parentage, i.e. volcanic-sedimentary. It is proposed that the unit represents a slump or subaqueous lahar type of deposit composed of ashy to pumiceous matrix which has incorporated fragments previously congealed of felsic volcanics. The unit subsequently has undergone metamorphism and deformation. This proposal would seem to best explain the distribution of fragments within the unit, their generally uniform composition, and its association with volcanic rocks deposited subaqueously without relying on a unique set of conditions of geological circumstance. This proposal may not be applicable to other breccia units with contrasting fragment-matrix compositions that have been described by Goodwin (1965) for the eastern Lake St. Joseph area.

FELSIC TO INTERMEDIATE METAVOLCANICS

Felsic to intermediate metavolcanics are not common within the Osnaburgh-Pickle Lakes belt. Where present, they occur as minor intercalations between mafic metavolcanics and their distinction in the field from sedimentary rocks is often difficult if not impossible. Primary textures have often been obliterated by metamorphism and/or tectonism.

Intermediate to felsic metavolcanic units are intercalated with mafic metavolcanics on the north and south shores of Pedlarpath Bay, Lake St. Joseph. The rocks are banded and on weathered surface, grey to grey-black. On fresh surface they are a medium grey. In thin-section the composition is visually estimated to be 40-50 percent fine-grained untwinned plagioclase with possibly some quartz, 40-50 percent actinolite-tremolite, and minor amounts of magnetite and garnet. The rock is thought to be andesite or dacite in composition.

METASEDIMENTS

Metasediments of greywacke, siltstone and argillite composition are the most dominant rock types after mafic metavolcanics. The metasediments are

concentrated in the Lake St. Joseph area and at a small unnamed lake approximately 2 km northeast of Doghole Lake.

Primary sedimentary features, other than bedding, are generally lacking except for grading of porphyroblasts in some bedded units in the Lake St. Joseph area. Metamorphism may produce porphyroblasts in a bed, exhibiting size gradation controlled by primary size gradation in the bed but with the size gradation reversed due to coarser porphyroblast development in argillaceous (formerly fine) segments of a bed and finer porphyroblasts in the silty or sandy (formerly coarse) segments of the bed.

At the small unnamed lake northeast of Doghole Lake the metasediments consists of bedded sericite-quartz-plagioclase-biotite schists of greywacke-argillite composition. Minor amounts of red garnet were noted on the weathered surface. The metasediments weather brown and are medium grained. Thin sections were not prepared from this unit. Its relatively high biotite (20 percent) content is thought to indicate, in part, a mafic volcanic source area, similar to the mafic volcanic rocks which enclose the unit.

The Doghole Lake metasediments situated in the northeast corner of the lake consist of a well bedded volcanoclastic sequence of rocks intruded with abundant granitic pegmatite. Individual sedimentary and volcanic units are generally less than 0.9 m in width and consist dominantly of waterlaid and reworked tuff and agglomerate. Minor amphibolitic units are also present. The matrix of the fragmental units is of the same general composition as the clasts but one unit consisting of mafic fragments in a felsic matrix was noted. The clasts generally do not exceed 7.5 to 10 cm in length and have undergone considerable elongation. Some units display some variation in clast size but the use of clast size as a stratigraphic top indicator gave conflicting results between closely spaced units. Most exposures display bedding or compositional layering and one displayed a crude crossbedding. The bedding is locally highly contorted due to granitic pegmatite intrusion and possibly tectonic activity. The rocks in the northeast corner of Doghole Lake have been mapped as metasediments but represent a mixed epiclastic-pyroclastic environment in which erosion, sedimentation and dominantly felsic volcanism were occurring concurrently. Other units within close proximity of this area and mapped as metasediments may reflect a similar depositional environment.

The rocks weather grey to brownish grey and are grey on fresh surfaces. A thin section prepared from a sample taken from one of the more massive, homogeneous beds was visually estimated to contain 10 percent sericite, 10 percent biotite, 35-40 percent each of polygonized quartz and untwinned plagioclase, and a trace of zircon and garnet. Most of the plagioclase is untwinned and is distinguished from the quartz by its slightly altered or turbid nature. The plagioclase is tentatively identified as calcic oligoclase.

Between Doghole Bay and the water control dam site on the channel between Lake St. Joseph and Osnaburgh Lake outcrops of biotite-chlorite-feldspar-quartz schist occur along the east shore of Lake St. Joseph. These rocks are well foliated, fine to medium grained, and weather grey-brown to grey-black. These rocks are thought to represent sediments of greywacke composition and were not examined in thin section.

A very interesting exposure of metasediments occurs at the water control dam site between Lake St. Joseph and Osnaburgh Lake. On weathered surface

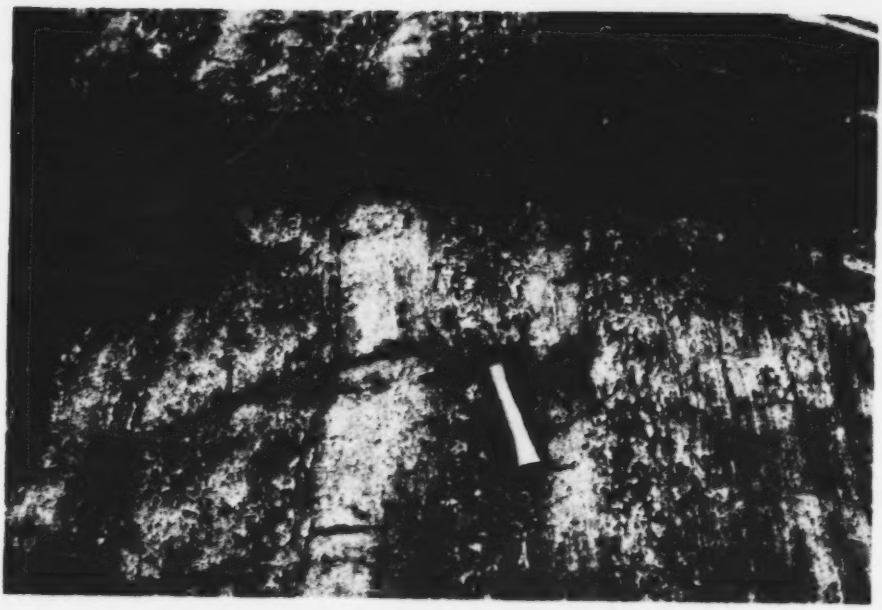

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Photo 18–Sillimanite and andalusite porphyroblasts in metasediments. Outcrop at watercontrol dam site at east end of Lake St. Joseph, Osnaburgh-Pickle Lakes belt.

bedding is well displayed and porphyroblasts of andalusite-sillimanite up to 2.5 cm in diameter stand out in relief (Photo 18). Metamorphism has resulted in a reversal of grain size with true stratigraphic tops to be north. The rock has a well developed foliation parallel to the bedding and weathers rusty brown. The rock on fresh surface is light brown with grey spots representing the andalusite-sillimanite porphyroblasts.

In thin-section (Photo 19) the rock is visually estimated to contain 20-25 percent sericite, 20-25 percent biotite, 15 - 20 percent sillimanite, 10-15 percent andalusite and 40-50 percent fine-grained polygonized quartz-plagioclase. The rock is relatively fresh in thin section.

A sample of andalusite-sillimanite schist was submitted for complete analysis (Table 12). The analysis shows relatively high Al_2O_3 with respect to the average for pelitic rocks. The analysis otherwise compares closely with those of other sillimanite-bearing rocks (Table 12) reported by Shaw (1956, Table 2, p.922). Assuming that the metamorphism of the sediment was isochemical the derivation of such a rock composition from the mafic volcanic rocks with which it is associated is difficult to explain. Goodwin (1965, p.12-13) reported whole rock analysis on both the felsic and mafic metavolcanics in the belt. These anal-

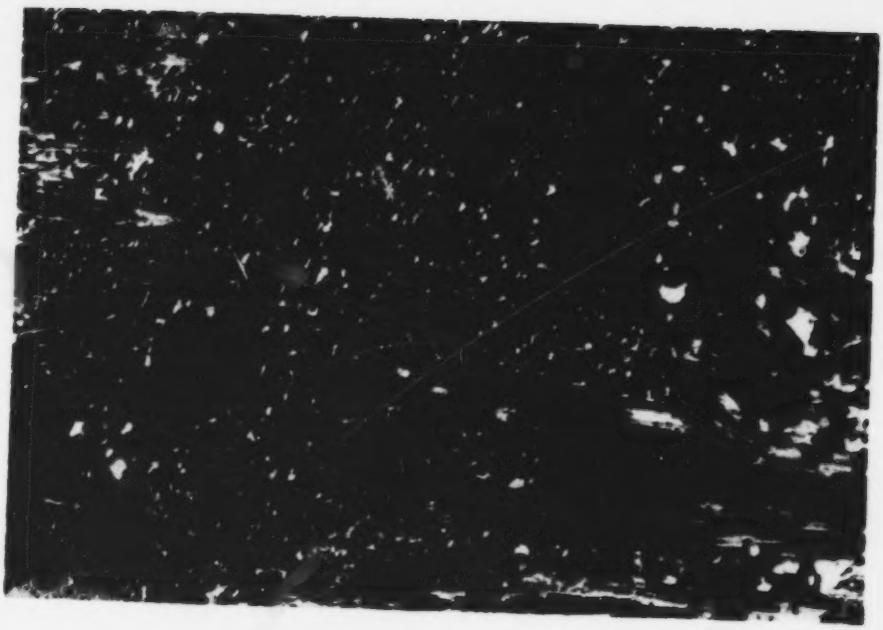

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Photo 19–Photomicrograph of sillimanite needles projecting into poikiloblastic andalusite containing small grains of quartz and plagioclase. Minor sericite and biotite also present. Sample from watercontrol dam site at east end of Lake St. Joseph, Osnaburgh-Pickle Lakes belt.

yses indicate Al_2O_3 contents ranging from 13.1 to 16.88 percent in these metavolcanics. To derive high alumina sediments from the volcanic rocks a weathering or leaching process is needed to concentrate the alumina and/or leach the other components. Possibly lateritic weathering or fumerolic activity would remove the alkalies and/or calcium leaving a sediment enriched in alumina. There is no evidence for paleosols or lateritic weathering within the metavolcanics of the belt nor is there any reference known to the authors which reports the development of alumina-rich soils in the Early Precambrian(Archean). As for fumerolic alteration, evidence of alteration which could be attributed to fumerolic activity has not been observed in the area. The presence of alumina-rich sediments in the area would require very extensive alteration of a large volume of volcanic rocks. It would be expected that some evidence of such a pervasive alteration would be preserved in the volcanic rocks.

A granitic source, in part, for Early Precambrian sediments has been proposed for sedimentary basins in northwestern Ontario by Donaldson and Jackson (1965), for the North Spirit Lake area and Walker and Pettijohn (1972), for the Lake Minnitaki area. Within the map-area, the conglomerates at Billett Lake in the Meen-Dempster Lakes belt, suggest a mixed granitic-volcanic

TABLE 12 MAJOR AND TRACE ELEMENT ANALYSES OF ANDALUSITE-SILLIMANITE SCHIST, OSNABURGH-PICKLE LAKES BELT. ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

Oxide	Sample DG4-16 Percent	Average comp. of pelitic rocks[1]
SiO_2	58.6	61.54
Al_2O_3	23.4	16.95
Fe_2O_3	1.04	2.56
FeO	4.64	3.90
MgO	2.40	2.52
CaO	1.23	1.76
Na_2O	1.80	1.84
K_2O	2.92	3.45
H_2O+	1.86	3.47
H_2O-	0.11	
CO_2	0.10	
TiO_2	0.91	0.82
P_2O_5	0.15	
S	0.01	
MnO	0.07	

Element	Sample DG4-16 ppm[2]
Ag	–(S)
As	3(C)
Ba	300(S)
Co	20(A)
Cr	100(S)
Cu	25(A)
Ga	20(S)
Li	100(S)
Mo	–(S)
Ni	35(A)
Pb	20(S)
Sb	1(C)
Sc	20(S)
Sr	1000(S)
V	40(S)
Y	20(S)
Zn	95(A)
Zr	10(S)
Be	3(S)
Sn	–(S)

[1] Average of 155 samples, Littleton Formation, New Hampshire (Shaw 1956).

[2] S = Emmission spectroscopy.
A = Atomic absorption.
C = Chemical.

source area and quartz-rich sediments of the Horseshoe Lake belt could have been derived, in part, from the surrounding granitic terrain. Glikson (1971, p.454) in studying the Coolgardie-Kurrawang sequence in western Australia proposed that argillite and greywacke within the belt were derived from sodic porphyry intrusions within the volcanic-sedimentary sequence and that the sediments were leached in soda and calcium. Such a process would increase the alumina content of the sediments and Glikson (1971, p.448) reported andalusite-bearing mineral assemblages for the Coolgardie-Kurrawang sequence. It seems most probable that the alumina-rich sediments observed in eastern Lake St. Joseph are the product of normal erosion of either the surrounding granitic terrain or of felsic intrusive rocks, and/or extrusive volcanic rocks related to the Early Precambrian volcanic activity in the Lake St. Joseph belt.

Of particular note in the trace element analysis (Table 12) is the high lithium content of the metasediment. Shaw (1956, p.931) mentioned that some rock specimens containing sillimanite, andalusite, and kyanite have high lithium contents, but he did not discuss any possible significance for these high concentrations. Within the general area Goodwin (1965, p.54) reported a lithium-bearing pegmatite in the southeast corner of Pashkokogan Lake. Assuming that the pegmatites in the eastern Lake St. Joseph area are anatectic in origin and derived in part from the metasediments with high lithium contents, a careful examination of the pegmatites should be made for the presence of lithium bearing minerals.

IRON FORMATION

In a road cut just north of the Rat Rapids crossing a thin 1.5 m, well bedded, fine grained saccharoidal, rusty brown, quartzite bed occurs between bedded tuffs and mafic metavolcanics. This unit is thought to represent a recrystallized chert horizon similar to chert commonly associated with Early Precambrian banded iron formation. Close to the contact, samples of foliated chlorite schists were collected which contained abundant garnet. Well developed banding or bedding in the recrystallized chert was noted and the contacts with the enclosing lithologic units showed evidence of shearing. The banding of the quartzite unit is locally highly folded.

A strong fish-hook shaped aeromagnetic anomaly which locally reaches an intensity of 75 000 gammas total absolute field occurs in the Pickle Lake area. This unit swings in an arc from an area northwest of Jean Lake, west of Keating Lake, and passes northeast of Dona Lake, before terminating between the Pickle Lake and the Hooker-Burkoski stock. This anomaly is interpreted by the author to indicate an iron formation (Map 923G, ODM-GSC 1960). Exposures of iron formation along this anomaly have previously been indicated by Hurst (1930) and Thompson (1939).

MAFIC INTRUSIVE ROCKS

In outcrops and road cuts along Highway 599 several occurrences of massive coarse-grained mafic rock were mapped as metagabbro. Individual hornblende grains vary up to 12 mm in length. These outcrops weather dark grey-black to greenish black and are intercalated with the metavolcanics. Because the exposures were massive and coarse grained they were mapped as mafic intrusive rocks, however, the possibility that some of these exposures represent thick flow centres cannot be discounted. Thin sections were not prepared from these outcrops.

ULTRAMAFIC INTRUSIVE ROCKS

In a roadside exposure just north of Rat Rapids a massive, narrow ultramafic sill intrudes the metavolcanic-metasedimentary sequence. The sill is approximately 15 m thick and lies between a sequence of well bedded waterlaid tuff and massive amphibolite to the west, and fine-grained well banded quartzite and massive amphibolite to the east. The rock has a very rough, pitted, rusty brown weathered surface; relief of the pitting is approximately 5 mm. The reddish brown weathering generally penetrates into the surface of rock for 3-4 mm but up to 2 cm in one area. On fresh surfaces the rock is distinctly spotted. The spots are circular, greenish-black and up to 10 mm in diameter set in a dark green matrix. The spots comprise a visually estimated 35 percent of the sample.

In thin section the spots were observed to consist of bluish green chlorite and minor relict olivine. The dark green matrix is largely actinolite with minor chlorite. Magnetite makes up 5-10 percent and carbonate 5 percent of the rock. An X-ray diffraction scan of the heavy mineral fraction disclosed the presence of serpentine in addition to the above minerals. The position of the 130 2θ peak for olivine on the X-ray diffraction scan would indicate a forsterite content of 60-65 percent. An X-ray diffraction scan of coarse-grained carbonate taken from an elliptical mass within the peridotite disclosed the presence of both dolomite and calcite; dolomite is dominant in the approximate ratio of 4:1. An X-ray diffraction scan of a fibrous mineral collected along the west contact of the peridotite indicated that it was an amphibole most probably of the actinolite-tremolite series.

Structural Geology

Meaningful structural data is lacking in the Osnaburgh-Pickle Lakes belt. Reverse graded bedding in metamorphosed aluminous sedimentary rocks at Osnaburgh House and the watercontrol dam site in eastern Lake St. Joseph indicate tops to the northeast. Pillow top data are not sufficiently reliable for meaningful interpretation of what is thought to be a rather complex structure. Foliations parallel the bedding and/or axial planes of the minor folds and the

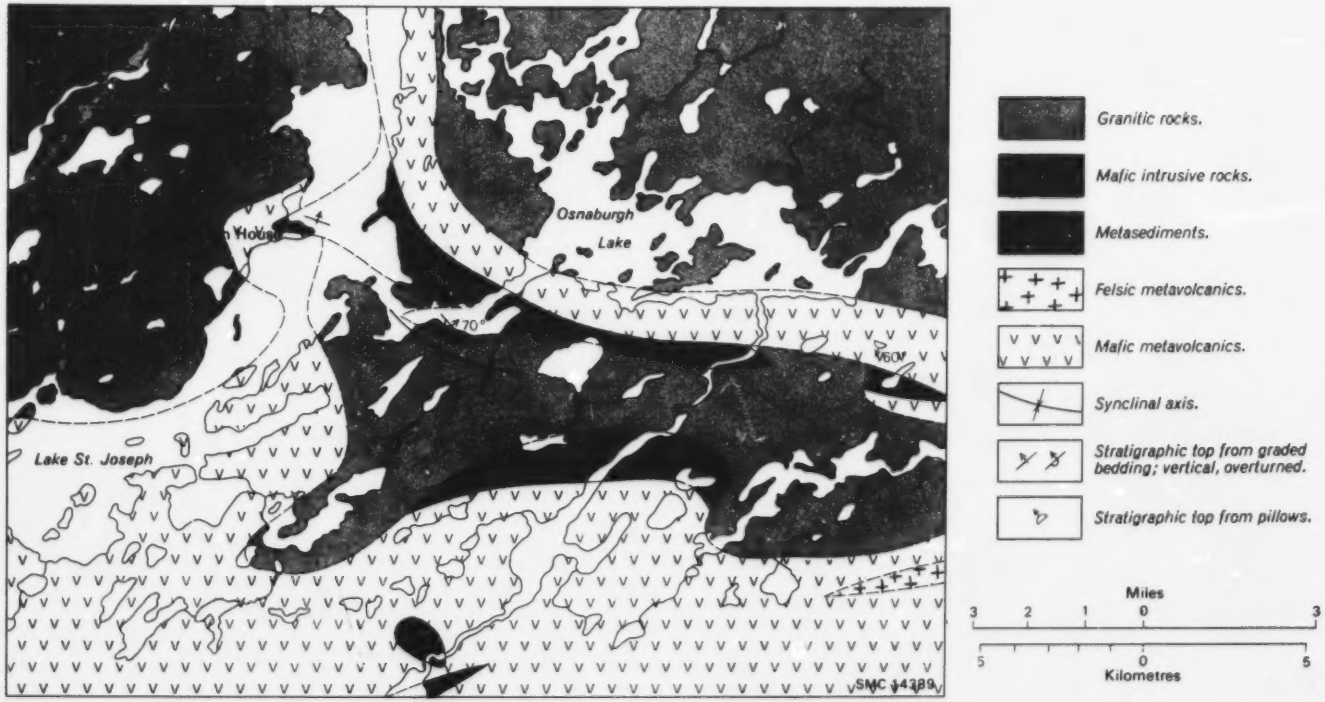

Figure 16–Alternate structural geology interpretation for the Osnaburgh House area of the Osnaburgh-Pickle Lakes belt. The indicated fold axis of the metavolcanics and metasediments is now occupied by unfolded granitic intrusive rocks.

linear features such as fragment elongation have a steep southeast plunge.

Extrapolating westward, from the south-facing pillow tops found on the south shore at Osnaburgh Lake, and using the two north-facing top determinations on reverse grading in the metasediments found at the watercontrol dam between Osnaburgh Lake and Lake St. Joseph and at Osnaburgh House, a synclinal axis could be postulated between Osnaburgh House and Rat Rapids.

This area also has a low aeromagnetic response (Map 922G, ODM-GSC 1960), characteristic of most granitic terrains. Thus this area may be underlain by a granitic body which is an extension of the granitic rock mass presently found at Eric Lake, and was emplaced along the axial plane of the postulated fold. This interpretation of the geology (shown in Figure 16), alternate to the one on Map 2218 (back pocket), should be considered by anyone contemplating additional work in the area.

In road cuts there is evidence of shearing parallel to formational contacts, and in some cases minor shearing was also observed to cut the formations at variable angles to the bedding. Several samples of granitic rock that flank the belt were examined in thin section. These samples all displayed moderate to strong cataclastic features. From field observations and samples of the enclosing granitic rocks, it can be concluded that the contact zone represents an interplay of magmatic and tectonic events. Granitic samples closest to the contact display the stronger cataclastic textures. The granitic rocks marginal to the belt vary from trondhjemite to quartz diorite in composition.

Economic Geology

Mineral exploration activity in the area has been recorded only relatively recently. Monpre Mining Company Limited in 1960 investigated several pyrite occurrences with low gold values in the Keating Lake area subsequent to airborne and ground electromagnetic, dip needle and geological mapping surveys (File 63.1098, Assessment Files Research Office, Ontario Geological Survey, Toronto). Minor trenching, and one packsack drill hole, 11 m long, intersected 1.5 m of disseminated to massive pyrite mineralization (Prospectus, Monpre Mining Company Limited, 1960). Union Miniere Explorations and Mining Corporation Limited (UMEX) in 1971-1972 sank 18 diamond drill holes totalling 958 m in the Dona Lake-Little Ochig Lake area, but encountered no economically significant sulphide mineralization (diamond drill records, Assessment Files Research Office, Ontario Geological Survey, Toronto, and private drill records, UMEX). Diamond drilling programs of the Canadian Nickel Company Limited were active in the Jean Lake area during 1971. One diamond drill hole (57 m) intersected minor iron sulphide mineralization (diamond drill records, Assessment Files Research Office, Ontario Geological Survey, Toronto).

Other mining exploration companies such as James Bay Mining Corporation, Conwest Exploration Company, and Transterre Explorations Limited had been active during 1971 to 1972 primarily in the Pickle Lake belt, and to a lesser extent in the Osnaburgh-Pickle Lakes and Dempster-Pickle Lakes belts. Mineral exploration here has mainly involved airborne and ground geophysics, geological mapping, and relatively little diamond drilling (Assessment Files Research Office, Ontario Geological Survey, Toronto).

PASHKOKOGAN LAKE-MISEHKOW RIVER BELT

The Pashkokogan Lake-Misehkow River belt (Figure 17, Chart B, back pocket) merges with the Lake St. Joseph and Osnaburgh-Pickle Lakes belt to the west. To the east and northeast aeromagnetic data and limited outcrop data indicate the belt is not connected to the metavolcanics of the Snowflake Lake area (Maps 945G, 946G, ODM-GSC 1960). Access to the belt is by float equipped aircraft and the outcrops are generally, although not universally, restricted to lake shores and stream banks. In some very localized areas the outcrop density may approach one percent.

The belt is composed primarily of mafic to intermediate metavolcanics but both felsic to intermediate metavolcanics and metasediments compose a significant portion of this "greenstone" belt. Pillow structures in the mafic to intermediate metavolcanics are not common. Pyroclastic textures in the felsic to intermediate metavolcanics are locally present, particularly at the south end of Lowry Lake. At Iron Falls on the Misehkow River muscovite, pseudomorphic after andalusite, is locally present and a unit of metasediments northeast of Lowry Lake contains well developed staurolite crystals. Within the area of East Pashkokogan Lake diamond drill logs submitted for assessment credit by Selco Exploration Limited indicate the presence of rocks classified as skarns and hornfels, some of which are garnet bearing.

Mapping in the Pashkokogan Lake area generally verified the previous mapping by Goodwin (1965), however some modifications have been made, based on assessment credit submissions and aeromagnetic interpretation. The Pashkokogan Lake-Misehkow River belt is interpreted to be a synformal structure from limited pillow top data.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Mafic to intermediate metavolcanics are the predominant rock type in the Pashkokogan Lake-Misehkow River belt. The rocks are generally fine grained, foliated to massive, greenish to green-black on weathered surface, and a lighter green to greenish black on fresh surfaces. Locally medium to coarse grained varieties are present which are interpreted to represent the centers of thick flows. The metavolcanics display a well developed schistosity in some of the exposures along the Misehkow River.

Pillow structures are not common within the belt. Their presence has been noted in the metavolcanics close to the granite-metavolcanic contact on the south side of Osnaburgh Lake, Lowry Lake, and on the northwest shore of the unnamed lake on the Misehkow River approximately 0.8 km northeast of Iron Falls. Minor mafic tuff and pyroclastic units intercalated with other lithologic units have been observed in the area of Iron Falls.

The metamorphic rank of the volcanic rocks ranges from greenschist facies

to epidote-amphibolite facies of regional metamorphism, and primary textures are not common. Rocks of the greenschist facies are generally confined to the center of the belt while rocks of higher rank are more common along the margins of the belt.

The greenschist facies rocks are characterized by actinolite-tremolite, carbonate, epidote-zoisite, and untwinned plagioclase. Trace amounts of opaques and quartz are common. Abundant biotite with minor sericite was noted in one thin section.

The amphibolites are characterized by pleochroic green hornblende set in a mosaic of polygonized untwinned plagioclase. The hornblende and plagioclase occur in approximately equal amounts however variations of up to 20 percent were noted in the relative proportions. Biotite may make up 15-20 percent of the rock in preference to hornblende. Minor amounts of calcite, epidote-zoisite, quartz, and magnetite are also present in some thin sections. In the Pashkokogan Lake area, garnet is common in some amphibolites and is easily recognized in the field where on weathered outcrop surfaces it will weather in relief as subspherical knots up to 3-5 mm in diameter.

FELSIC TO INTERMEDIATE METAVOLCANICS

Felsic to intermediate metavolcanics comprise flows and pyroclastics, and are the second most important lithologic unit within the Pashkokogan Lake-Misehkow River belt. The felsic to intermediate metavolcanics are light grey to buff in colour on weathered surfaces, medium to dark grey on fresh surface, fine grained, well foliated, banded and massive. On fresh surfaces discontinuous hairline streaks of biotite or hornblende disclose some segregation of the mafic component. The pyroclastics display a marked elongation of fragments and often have a rather diffused boundary with the enclosing matrix. Fragmental textures are best discerned on the weathered outcrop surface and spectacular examples are located on a small island at the south end of Lowry Lake (Photo 20), on a small unnamed lake approximately 1.5 km north of Rockcliff Lake, and along the river banks of the Misehkow River south of the Webb Lake stock. The felsic fragments in the pyroclastic rock exposures weather grey-white in colour in a darker grey matrix. The long axis of the larger fragments are approximately 0.3 m in length. The weathered surface appears somewhat banded and acicular amphibole crystals appear along the foliation planes of the rock. Yellowish green tints on some fresh surfaces suggest the presence of epidote. The felsic fragments along the Misehkow River are ellipsoidal and less deformed than those on Lowry Lake. They were noted to occur up to 15 cm in maximum length. If fragment size can be taken as an indicator as to the proximity of source, then the area near Lowry Lake is probably closest to a volcanic vent.

In thin section the samples are visually estimated to contain 50-70 percent fine grained mosaic of plagioclase and quartz, 10-20 percent biotite, 10-15 percent hornblende, 0-10 percent chlorite, 0-15 percent epidote-zoisite, and 0-5 percent sericite. Carbonate, opaques, and garnet were also noted as minor components. Foliation in the the felsic to intermediate rocks is defined by the mafic components which generally are discontinuous streaks of biotite and/or horn-

OGS 10 277

Photo 20–Elongated felsic clasts in a felsic breccia outcropping on a small island at the southeast corner of Lowry Lake, Pashkokogan Lake-Misehkow River belt.

blende. Epidote, sericite, chlorite, and carbonate occur as alteration of the mafic and felsic components. Domains of varying grain size within the polygonized quartz and plagioclase in some samples may represent former clasts. Occasionally sutured grain boundaries exist between the quartz and plagioclase. In one sample of porphyroclastic tuff, in which nearly all the feldspar crystals were fragments, one crudely euhedral crystal displayed a very well developed zoning.

The felsic to intermediate metavolcanics of the Pashkokogan Lake area have been analyzed by Goodwin (1965, p.32) and determined to be rhyodacite and dacite. The felsic to intermediate metavolcanics of the Lowry Lake area are of the same composition. For a more detailed description of the Pashkokogan Lake felsic metavolcanics, the reader is referred to the report by Goodwin (1965).

Some of the rocks described as metasediments by Dyer (1934, p.10-11) have been reinterpreted as felsic pyroclastics.

METASEDIMENTS

Metasediments occur in a number of places within the belt, most commonly as minor units intercalated with the metavolcanics. The metasediments consist of argillite and greywacke. The metasediments form a mappable unit north of Lowry Lake, at a small unnamed lake 4 km northeast of Eric Lake, and at Iron Falls where metasediments were outlined by diamond drilling (Hudson Bay Exploration and Development Company Limited, File 63.3030, Assessment Files Research Office, Ontario Geological Survey, Toronto) and by a single outcrop.

At Iron Falls argillite is associated with fine grained volcanic ash. The argillite is particularly noticeable just above the falls where muscovite pseudomorphs after andalusite (var. chiastolite) up to 2.5 cm in length are found in outcrop. The pseudomorphed porphyroblasts weather a rusty brown on the outcrop surface and do not stand out in relief. On a sawed surface the cross of the former andalusite (var. chiastolite) is unmistakable. In thin section it was observed that the chiastolite has been pseudomorphed by a very fine-grained felted matte of sericitic mica. The identity of the sericite mica was confirmed by X-ray diffraction. The argillite foliation bends around the pseudomorphed porphyroblasts and chlorite is common along the margins of the porphyroblasts. The matrix of the sample in thin section appears to consist of a very fine-grained mixture of chlorite, quartz, and plagioclase. One composite quartz fragment with a mosaic texture was noted in thin section and is interpreted to have been a former chert fragment.

The metasediments north of Lowry Lake consist mostly of rusty brown weathering fine grained biotite-quartz-plagioclase schist most probably derived from greywacke-argillite type sediments. Locally very well developed staurolite porphyroblasts are present which are commonly associated with minor white coarse grained pegmatitic granitic intrusions. The staurolites occur as single, chocolate brown prisms up to 2.5 cm in length. The crystals are commonly very well formed, and are distinctly lighter in colour than those found on Soules Bay, Lake St. Joseph. A thin section was not prepared from this unit.

The metasedimentary unit occuring 4 km northeast of Eric Lake has been previously mapped by Goodwin (1965, Map 2096). This unit was examined and found to consist of well bedded, rusty brown weathering biotite-chlorite-quartz-plagioclase schist cut by white granitic pegmatite. This unit was not examined in thin section.

Along the south shore of Pashkokogan Lake a unit formerly mapped as felsic metavolcanics (Goodwin 1965, Map 2094) has been reclassified as metasediments, based largely on diamond drill logs submitted for assessment credit by Selco Exploration Limited.

IRON FORMATION

Iron formation was not observed in outcrop but a prominent linear aeromagnetic anomaly (Maps 922G and 932G ODM-GSC 1960), locally reaching 70 000 gammas absolute total field intensity, is located along the northern margin

of the belt. The writer believes that this anomaly indicates the presence of iron formation. At a small unnamed lake on the Misehkow River approximately 0.8 km northeast of Iron Falls aeromagnetic data suggests that the iron formation has thickened, perhaps due to folding of the iron formation at this location which is along the proposed axis of the Pashkokogan Lake-Misehkow River syncline. Sturdy Mines Limited have diamond drilled the iron formation along the Misehkow River at this aeromagnetically indicated thickened portion. Core chips found at the property indicate that the iron formation consists of well banded chert-magnetite iron formation with the bands varying from 1 mm to 3 cm in width. The chert is dark to light grey. Minor amounts of greywacke and thin seams of pyrite are also indicated to be present.

Dyer (1934, p.12) reported the presence of iron formation approximately 1.5 km north of the north end of Woodilee Lake and 3 km north of Iron Falls. These occurrences are located along the aeromagnetically indicated iron formation. Dyer (1934, p.12) described this iron formation as consisting of alternating bands, about 15 cm in width, of magnetite and white and yellow silica in association with quartz-biotite gneiss.

MAFIC INTRUSIVE ROCKS

Isolated exposures of massive coarse-grained mafic rocks occur within the belt. From the limited exposures it is often impossible to determine if the coarse grained mafic rocks represent coarse grained flow centres or mafic intrusions of gabbro, diorite, or hornblendite composition. Regardless, such occurrences rarely form a mappable unit at the present scale of mapping.

Rocks thought to be possibly representative of minor mafic intrusions have been noted at the north end of Woodilee Lake, as inclusions in an intrusion breccia (Photo 21) along the south margin of the Webb Lake stock, at the east end of Frain Lake, intermixed with mafic metavolcanics 0.8 km southwest of Lowry Lake, in several roadcuts along Highway 599, and as generally scattered occurrences along the northern edge of the belt.

Approximately 1 km south of the junction of the Pashkokogan River and Osnaburgh Lake several medium grained mafic outcrops in combination with aeromagnetic data (Map 922G, ODM-OGC 1960) are interpreted to indicate a small mafic intrusion. This intrusion is estimated from the aeromagnetic maps to be approximately 0.3 km^2 in surface area. Another small intrusion was located by diamond drilling (Report 15, Falconbridge Nickel Mines Limited, Assessment Files Research Office, Toronto) on the Pashkokogan River just north of Pashkokogan Lake.

A thin-section was prepared of a sample from the small mafic body at the north end of Woodilee Lake and it was visually estimated to contain approximately 70 percent actinolite, 10 to 15 percent chlorite and 20 percent very fine grained plagioclase. The rock of this mafic body is typically medium to coarse grained, well foliated, black weathering, and megascopically apparently composed entirely of amphibole and chlorite. On fresh surface the rock is medium to dark green and consists of a silky mass of chlorite and fibrous amphibole.

OGS 10 278

Photo 21–Massive medium grained brecciated gabbro intruded by dioritic rock. Possibly marginal to the Webb Lake stock. Outcrop occurs on a small lake approximately 9 km southwest of Iron Falls. Pashkokogan Lake-Misehkow River belt.

DIABASE DIKES

The Pickle Crow diabase dike cuts the Pashkokogan Lake-Misehkow River belt. This dike is a regional feature described under "Late Precambrian".

Structural Geology

Foliations within the belt parallel the bedding with local deviations marginal to the granitic intrusions. The belt itself may be an isoclinally folded syncline but this interpretation is based on only four pillow top determinations. The top determinations on the south side of Osnaburgh Lake are considered reliable, however those on the Misehkow River northeast of Iron Falls and on Lowry Lake are more questionable.

Along the Misehkow River from Iron Falls northeastward outcrops of mafic metavolcanics are very schistose. Locally kink folding is weakly developed in these schistose metavolcanics. It is thought by the writer that the schistosity

and kink folding are the result of shearing along the axis of the Pashkokogan Lake-Misehkow River syncline which follows the Misehkow River at this point. Kleist (1972) has demonstrated a possible relationship between kinking and strike slip movement on the Denali fault zone in Alaska and a similar feature may be present here. Dyer (1934, p.14-15) interpreted a synclinal structure for the Pashkokogan Lake-Misehkow River belt and postulated the possibility of faulting and/or shearing along the fold axis of the belt.

The northern contact of the belt appears to be characterized by granitic intrusion and cataclastic textures. One thin section was prepared from the granitic rocks marginal to the north contact. In thin section the rock was visually estimated to contain 30-35 percent quartz, 40-45 percent oblate plagioclase porphyroblasts of albite composition, 10-15 percent biotite, and 20-25 percent finer grained plagioclase. Sericite, epidote-zoisite, and sphene occur in minor amounts. The larger plagioclase clasts are partially saussuritized and are set in a much finer, fresher appearing groundmass of quartz, plagioclase, sericite and biotite. The rock has a well developed foliation due to a preferred orientation of the biotite grains. The grain boundaries of the quartz and plagioclase of the matrix form a polygonal mosaic pattern. The rock is an albite trondhjemite that has undergone strong cataclasis and some recrystallization.

The southern contact of the belt for most of its strike length is the boundary between the English River Subprovince and the Uchi Lake Subprovince of the Superior Province. Limited mapping during this survey along and across this metavolcanic-gneiss contact has indicated the presence in the contact zone of the English River Subprovince of well foliated, fine-grained, biotite-quartz-plagioclase schist which was initially mapped in the field as sedimentary in origin but on thin section examination appeared in part to be cataclastic intrusive rocks of trondhjemitic composition. Megascopic examination of sawed surfaces of samples of this rock reveals augenlike clasts up to 1 mm in diameter. The rock is well banded with thin 1 mm discontinuous streaking. The banding is due to variations in relative mineral percentages.

Examination in thin section reveals that the augenlike clots consist of composite aggregates of quartz with sutured grain boundaries and pronounced undulatory extinction. The groundmass consists of a fine-grained mosaic of quartz and untwinned plagioclase with well developed polygonal texture. The biotite crystals show a pronounced preferred orientation which enhances the foliation of the rock. The rock is considered to be cataclastic, recrystallized, and of unknown primary origin. Based upon the recognition of these cataclastic textures the Pashkokogan Lake-Misehkow River belt is considered to be in fault contact with the English River gneisses for at least a portion, perhaps all, of its length.

The relationship of the Pashkokogan Lake-Misehkow River belt to the granitic rocks of the Uchi Lake Subprovince, and gneisses of the English River Subprovince along its eastern extension, is unknown due to the lack of outcrop.

Economic Geology

There is no record of any early prospecting within the belt. Interest in this relatively unknown belt was no doubt heightened by release of the federal-provincial aeromagnetic maps in 1960.

A prominent iron-formation unit north of Woodilee Lake, first described by Dyer (1934, p.12), was aeromagnetically surveyed in 1960, by Monpre Mining Company Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto). The strongest magnetic anomaly was covered by eight claims situated 1.5 km due north of Woodilee Lake (Resident Geologist's Files, Ministry of Natural Resources, Sioux Lookout). The gold possibilities of this iron-formation were investigated by ground electromagnetic, dip needle, and geological surveys. Three occurrences of disseminated pyrite were exposed, although assays proved only traces to nil quantities of gold, silver, and copper to be present (Assessment Files Research Office, Ontario Geological Survey, Toronto). Several years earlier, this area was purportedly investigated by W. S. Moore Limited through an airborne magnetic survey and staked as an iron property (Prospectus, Monpre Mining Company Limited, 1960). In 1968, Sturdy Mines Limited re-examined this property for its iron potential by ground electromagnetic-magnetic surveys (Assessment Files Research Office, Ontario Geological Survey, Toronto). On claim PA44387 copper-nickel mineralization was discovered by this exploration company. Mineralization here was briefly examined by the present survey and is described in detail below. Near Iron Falls on the Misehkow River, Sturdy Mines Limited staked 45 claims in 1968 over an aeromagnetically prominent iron formation unit. Development work outlined an iron deposit of possible future economic potential. From 1970 to 1971 a major exploration program by Hudson Bay Exploration and Development Company Limited was directed towards a search for volcanogenic base-metal sulphide deposits in the Lowry Lake area (Assessment Files Research Office, Ontario Geological Survey, Toronto) An area of 540 km^2 was subject to an airborne electromagnetic survey. A total of 221 claims were staked during these two years. Follow-up ground electromagnetic surveys ensued over eight grids. Thirty-seven diamond drill holes totalling 3873 m probed the major electromagnetic conductors. The program was augmented by soil geochemical sampling for copper and zinc over most of the grids and by cursory geological mapping. In 1971 due to greatly disappointing results this company decided to terminate their interest in the Lowry Lake area.

Canadian Nickel Company Limited recorded 709 m of diamond drilling (12 holes) in the nearby Osnaburgh Lake-Caron Creek area in 1971.(Diamond Drill Reports, Assessment Files Research Office, Ontario Geological Survey, Toronto). Considerable ground geophysical surveying and diamond drilling have been carried out by Selco Exploration Company limited in the vicinity of Pashkokogan Lake in 1971 (Assessment Files Research Office). Within the belt area this company diamond drilled six holes totalling 584 m, intersecting barren sulphide mineralization, often accompanied by graphite. Falconbridge Nickel Mines Limited in 1972 intersected similar sulphide mineralization in two diamond drill holes (107 m) on the Pashkokogan River very near Pashkokogan Lake (Assessment Files Research Office).

PROPERTY DESCRIPTIONS

Very few exposures of economic mineralization are known in this belt. Prospecting is thwarted by a widespread covering of glacial overburden.

Misehkow River Iron Prospect

A potentially promising iron deposit was outlined in 1968 by Sturdy Mines Limited. Exposures in the area are rather minimal and no outcrops of the iron formation could be located for direct examination. The Misehkow River appears to follow along the iron formation east of Iron Falls.

Much of the following discussion is inferred and abstracted from the diamond drill logs of Sturdy Mines Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto). The rock types examined in the area along the northwestern shoreline of the Misehkow River, contiguous to the iron formation, are dominantly mafic metavolcanics consisting of an assemblage of massive to pillowed flows with the former occasionally displaying relatively coarse-grained centers. Several exposures of massive to foliated rhyolitic to dacitic flows and tuff to lapilli tuff units are notably intercalated within the dominant mafic metavolcanic assemblage. Specifically, as ascertained by diamond drill data, the iron formation is almost invariably bounded stratigraphically, above and below, by metasediments consisting principally of thinly bedded, graphitic, often silicified, dark metagreywacke and interbedded sericitic quartzite. In one diamond drill hole (SM-4), banded siliceous rhyolite is in contact with the iron formation.

The iron formation consists of very uniform well bedded chert-magnetite layers with minor hematite and sulphide minerals in a few local areas. The diamond drill program (six holes totalling 1592 m) followed the iron-formation along a strike length of 1630 m, with the east and west ends still open. Tonnage to the 150 m (500 foot) depth is estimated at 64 555 000 tonnes (71 160 000 tons) grading 21.0 percent total iron (Sullivan 1968, p.1). Grade of the deposit was indicated to vary from 17.3 percent total iron over 93 m to a maximum of 28.4 percent total iron across 43 m (Sullivan 1968, p.3). Width of the iron formation varies from 48 m to 155 m and appears to gradually narrow westwards. Preliminary magnetic concentration tests on a minus 325 mesh composite sample from drill hole SM-1 resulted in the following analysis: 64.0 percent iron, 10.3 percent SiO_2, 0.05 percent P_2O_5, 0.09 percent TiO_2, 0.04 percent S, and 1.20 percent Al_2O_3 (Sullivan 1968, p.3).

Sturdy Mines Copper-Nickel Occurrence

A brief examination was made of a copper-nickel occurrence, 1.5 km N30E of Woodilee Lake, previously investigated by Sturdy Mines Limited in 1968. Development work by this company involved blast-stripping, trenching and three Winkie diamond drill holes (total length unknown).

Geology. The copper-nickel mineralization occurs along the north contact of an east-trending dominantly coarse-grained gabbro dike. On site of the mineralization this dike intrudes concordantly to subconcordantly into fine-grained, foliated, light grey (weathered surface), leucocratic, possibly felsic tuff. The

attitude of the felsic tuff foliation measured at the north contact of the dike is N70E, and dip is 60S. Elsewhere in the area, amphibolitized foliated fine-grained mafic metavolcanics abound. The gabbro dike, which is approximately 210 m wide in the vicinity of the mineralization, noticeably becomes finer grained and more strongly foliated towards the southern contact. Aligned xenoliths of fine-grained mafic metavolcanics and thin wispy streaks of felsic material are sparsely distributed in the more strongly foliated southern part of the dike. Milky-white to locally rusty quartz veins are common in the mineralized gabbro, emplaced either concordant or subconcordant to the foliation.

Mineralization. Mineralization occurs only in the metagabbro and appears to be partly controlled by the contact between the gabbro dike and felsic tuff to the north. The mineralized zone is traceable for a strike length of 90 m and appears to narrow from 3 to 4.5 m at the easterly end of the trenched area to about 0.3 to 0.6 m at the westerly end. Pyrrhotite and chalcopyrite are the only sulphide minerals present and are largely disseminated interstitially among the silicate minerals. Local sulphide masses consisting principally of pyrrhotite can comprise up to 10 percent of some grab samples, however, these segregations are generally uncommon. Pyrrhotite, which is characterized by a purplish bronze colouration on fresh untarnished surfaces, is the predominant sulphide mineral and usually does not exceed 3 to 4 percent of this rock. Numerous fractures of varying attitudes transect the mineralized zone. The great majority of such fractures are coated with limonite and rare malachite staining.

Four grab samples ranging from well mineralized (approximately 10 percent total sulphide) to sparsely mineralized (1 to 3 percent total sulphide) were selected by the field party for analysis by the Geoscience Laboratories, Ontario Geological Survey. These results (Table 13) indicate a rather constant nickel abundance and variable copper values. Somewhat higher values of these metals have been reported by Shklanka (1968, p.174-175): "Samples from a trench have averages of 0.66 percent copper, 0.25 percent nickel, and 0.12 percent cobalt. Best assay was 1.22 percent combined copper-nickel across a width of fifteen feet." Only trace amounts of cobalt were detected by emission spectrographic analysis of the four grab samples. No platinum group metals were detected. Trace quantities less than 0.005 ounces per ton palladium group metals appeared in all four grab specimens.

RECOMMENDATIONS FOR FUTURE EXPLORATION

The large felsic to intermediate metavolcanic unit between Rockcliff Lake and Iron Falls delineated by the present survey is of prime importance. Detailed geologic mapping is warranted to assess the full extent of this large unit and the distribution within the unit of coarse-pyroclastic zones which may be favourable for base metal sulphide mineralization. It is notable that the mineral exploration program of Hudson Bay Exploration and Development Company Limited detected several "low priority" electromagnetic conductors over this unit but these conductors were not investigated by follow-up geological

TABLE 13 | **ASSAYS OF GRAB SAMPLES OF MINERALIZED GABBRO, STURDY MINES LIMITED COPPER-NICKEL OCCURRENCE, PASHKOKOGAN LAKE-MISEHKOW RIVER BELT.**

Sample Number	Description	Copper	Nickel	Gold*	Silver
HDG10-5	Medium to fine grained metagabbro, 10 percent total sulphide	0.48%	0.17%	trace	trace
HDG10-6	Medium-grained metagabbro, 1-3 percent total sulphide	0.14%	0.16%	trace	trace
HDG10-7	Medium-grained metagabbro, 8-10 percent total sulphide	0.30%	0.15%	trace	trace
HDG10-8	Foliated medium-grained metagabbro, 3-5 percent total sulphide	0.22%	0.17%	0.01	trace

*in ounces per ton
Assays by Geoscience Laboratories, Ontario Geological Survey.

mapping or diamond drilling (B. Cairns, Hudson Bay Exploration and Development Company Limited, personal communication)

SNOWFLAKE LAKE BELT

The Snowflake Lake belt is the western extremity of the Miminiska Lake-Fort Hope belt (Thurston and Carter 1970; Ayres *et al.* 1971). Only one outcrop was located within this belt, on the south shore of the Albany River approximately 3 km south of Snowflake Lake. The exposure consists of mafic metavolcanics, iron formation and one thin unit of felsic tuff.

A prominent, but narrow magnetic feature trends westward beyond Snowflake Lake through Crerar and Napier Lakes (Map 944G, ODM-GSC 1960). This feature is less than 1.5 km in width and is considered by the writer as indicative of amphibolitized mafic metavolcanics which have been intruded by granitic rocks. Limited and scattered outcrop data tends to indicate that the Snowflake Lake belt and the Pashkokogan Lake-Misehkow River belt are now separated by granitic rocks even though the two belts may have been continuous at one time (Ayres *et al.* 1971).

The Snowflake Lake metavolcanics are interpreted from aeromagnetic data to wrap around a granitic intrusion which extends eastwards beyond the boundary of the map-area (Map 944G, ODM-GSC 1960). The belt is covered by

thick morainal deposits of the Agutua Moraine. Diamond drill logs submitted for assessment work credit by the Canadian Nickel Company of Canada Limited for work done in 1972 indicate mafic and felsic metavolcanics, iron formation, quartzite, tuff, and agglomerate.

General Geology

MAFIC TO INTERMEDIATE METAVOLCANICS

Most of the outcrop exposure on the south side of the Albany River consists of massive mafic metavolcanics which are composed of actinolite, chlorite and calcite. The rocks are fine-grained and generally weather dark green. On fresh surface they are dark greenish black.

On the far eastern extremity of the outcrop, a mafic metavolcanic unit has a spotted appearance on the weathered surface. The spots are 4-5 mm in diameter and are thought to be representative of former variolites. In thin-section a sample from this unit was visually estimated to contain 55-65 percent actinolite, 10 percent carbonate, and 15-20 percent very fine grained plagioclase. One spherical spot (which consisted of a carbonate core surrounded by a felted mass of actinolite) was observed. Another unit in this sequence of metavolcanics at this exposure had a very jagged, clinkery appearing weathered surface. The mode of this sample was estimated in thin section to be 10 percent carbonate, 65-70 percent actinolite, 20-25 percent chlorite, 15 percent plagioclase and minor limonite. Megascopic examination of a slabbed sample of this unit indicates the rock is largely fragmental and consists of elongated subspherical fragments with maximum long axes 4-5 mm in length. The fragments are now largely composed of felted masses of actinolite. The rock is classified as lapilli tuff.

The rocks have been metamorphosed to the lower greenschist facies of regional metamorphism (Turner and Verhoogen 1960).

FELSIC TO INTERMEDIATE METAVOLCANICS

On the same outcrop area on the Albany River, a thin felsic tuff unit about 0.6 m in width lies between the east contact of the iron formation and mafic metavolcanics. This unit weathers grey and is grey-green on fresh surface. The unit consists largely of clastic feldspar grains. A thin section was prepared from this unit and its mode visually estimated to be 5 percent carbonate, 35-45 percent angular plagioclase feldspar clasts of andesine composition, 15-20 percent epidote-zoisite, 3-5 percent biotite and 40-45 percent fine-grained plagioclase and quartz. The quartz content is difficult to determine but probably does not exceed 5 percent of the rock. All the plagioclase crystals were fragments and some of the larger feldspar clasts contained microfractures. The unit is considered to be a crystal tuff.

Of particular note was the presence of iron formation fragments (up to 10

cm in length) within the tuff along the western contact of the tuff unit. These fragments are similar in composition to the iron formation lying along the west contact. It is thought that these fragments are derived from this iron formation unit and incorporated into the base at the tuff unit. Thus, the stratigraphic top of the sequence would be towards the east.

IRON FORMATION

A 9 m wide unit of very fine grained banded chert-magnetite iron formation is present in the exposed sequence of rocks. This unit consists of dark blue-grey chert and magnetite bands with traces of pyrite, varying from 2 mm to nearly 7.5 cm in width. The formation shows moderate open folding of the banding which possibly may have arisen by soft sediment deformation prior to consolidation. Along the west contact, possibly the base of the unit, a thin massive pyrite unit varying from 2.5 to 15 cm in width was noted. The presence of the sulphide mineralization is indicated by the pronounced rusty weathering of the west contact. Towards the west, the iron formation lies in contact with massive mafic metavolcanics. A chip sample of this unit was taken at 0.3 m intervals across the strike (see "Economic Geology").

On aeromagnetic maps 944G and 943G (ODM-GSC 1960) a linear magnetic trend roughly forms a loop open to the northwest. Locally the loop reaches a magnetic intensity of 67 000 gammas. The aeromagnetic trend is interpreted as indicating the presence of iron formation. The iron formation examined in outcrop occurs on this aeromagnetic trend.

Structural Geology

Since only one exposure on this belt was observed, only a limited amount of interpretation is possible. Foliations in the metavolcanics parallel the vertically dipping bedding and the units strike southwest at an angle of approximately 80 degrees to the direction of flow of the Albany River. Minor open folding in the banded iron formation is possibly a primary feature due to slumpage rather than a later period of tectonism. Minor shearing parallel to the direction of flow of the Albany River (i.e. roughly east-southeast) was noted. Extrapolating the one top determination (iron formation fragments in the assumed base of the crystal tuff) along the strike of the aeromagnetically inferred loop in the iron formation, one can postulate an antiformal structure. The minor shearing observed in the outcrop, as well as the watercourse of the Albany River, would then lie along the axial plane of this inferred fold.

Economic Geology

Prospecting is greatly hampered by lack of bedrock exposure. The only record of mineral exploration is relatively recent. Canadian Nickel Company Lim-

ited probed several airborne conductors by diamond drilling during 1971-1972 in the Crerar-Snowflake Lakes area. A total of 421 m of diamond drilling was recorded in six holes (Diamond Drill Records, Assessment Files Research Office, Ontario Geological Survey, Toronto). No important mineralization was reported.

The present survey made a brief examination of a well exposed, composite oxide-sulphide iron formation situated on the Albany River. A massive pyritic zone varying in width from 2 to 15 cm is present along the base of the 9 m wide banded oxide facies iron formation. A composite sample of the oxide facies iron formation was submitted to the Geoscience Laboratories, Ontario Geological Survey for partial analysis and found to contain 60.7 percent SiO_2, 22.8 percent iron, 0.16 percent P_2O_5 and 0.22 percent sulphur. A sample of the pyrite member contained only trace gold and no significant concentrations of economically important elements were revealed by emission spectrographic analysis.

English River Subprovince

A small segment of the English River Subprovince extends through the southeastern section of the map-area.

General Geology

METASEDIMENTS

The English River Subprovince within the map-area is principally underlain by fine-grained detrital metasediments and various intrusive phases of massive leucocratic coarse-grained to pegmatitic granitic rocks with lesser volumes of clastic magnetite-metagreywacke iron formation bands and very minor amphibolite units.

The detrital metasediments are fine-grained, equigranular, weakly to strongly foliated rocks which have been pervasively transformed by amphibolite facies rank regional metamorphism to biotite-quartz-plagioclase±garnet schists and gneisses. Weathered surfaces usually vary from light tan to rusty brown with the latter colouration arising from dissolution of minute disseminated pyrite grains. Grey fresh surface colours are typical. Foliate structures are best detected on weathered surface, and are manifested by the preferred orientation of biotite and elongate plagioclase and quartz grains. Lack of primary detrital structures in outcrop and in thin-section precludes determination of the original sedimentary mineralogy and the relative proportion of framework and matrix components. In very rare instances, primary structures exist or are inferred to have persisted through metamorphism. Thinly developed bedding (15 cm) was noted in two localities, at the western end of "Heart Attack" Lake (local name) and along the western shoreline of Murrell Lake. Possible graded bedding, although not observed in the map-area, has been noted elsewhere

TABLE 14 | MODAL ANALYSES OF METASEDIMENTS FROM THE ENGLISH RIVER SUBPROVINCE.

	DH14-4	DH15-15A	DH15-6	DH15-9	HDH12-2
Plagioclase	45.9	41.5	37.9	54.1	48.8
Quartz	32.5	34.7	43.3	23.0	27.7
Biotite	21.1	23.3	17.4	-	21.5
Hornblende	-	-	-	20.1	-
Muscovite	-	0.2	0.9	0.4	-
Garnet	0.4	0.2	x	-	1.6
Zircon	-	x	0.2	1.9	x
Chlorite	x	-	-	0.4	-
Epidote	-	-	x	0.2	0.2
Apatite	x	-	0.2	-	0.2
Iron Ore	0.1	0.2	0.2	-	-
Tourmaline	-	x	-	-	-
Color Index	26.6	23.7	17.6	20.1	23.7

Modal analyses by F.W. Breaks, on thin-sections stained for plagioclase, based upon 500 points.

x – Present in trace amounts.

within the English River Subprovince in the Ear Falls area 90 km west of the western boundary of the map-area. Here, portions of alleged beds show a gradual megascopic increase in biotite content. The biotitic-rich fraction is interpreted to indicate the original upper argillaceous component of a graded bed.

Twelve thin sections, stained for plagioclase and potassic feldspar, were briefly examined, with modal analyses performed on five of the specimens (Table 14). Well developed polygonal lobate granoblastic textures were observed in thin section with grain diameters typically ranging between 0.2 mm and 0.5 mm. Plagioclase, usually the most abundant mineral, occurs as fresh to sericitized polyhedral grains, devoid of strain effects, in which individual grains commonly meet in triple point junction at angles of approximately 120 degrees. Quartz, which displays the greatest modal variation is characterized by discrete, smooth lobate grain boundaries between adjacent mineral phases. Subhedral red-brown biotite is a ubiquitous characteristic accessory mineral, commonly studded with diminutive zircons marked by pleochroic halos. Accessory minerals commonly present are garnet, zircon, apatite, epidote, magnetite, chlorite, and tourmaline. Colour index of the metasediments is generally very consistent as indicated in Table 14 and usually is dominated by biotite.

Hornblende and actinolite respectively represented the dominant mafic mineral in two thin sections.

Several thin sections revealed evidence of a greenschist facies retrograde metamorphic event principally manifested by:

(1) sericitization of plagioclase,
(2) chloritization of biotite,
(3) muscovitization of biotite,
(4) recrystallization of quartz (suturing of grain boundaries), and
(5) veining of garnet by chlorite (rare).

The intensity of retrograde metamorphism varies from almost complete replacement of plagioclase and biotite by secondary minerals to virtually fresh and relatively stain-free metamorphic assemblages.

Wine-red almandine garnet is a widespread minor accessory occurring in both the metasediments and the granitic pegmatites. Occasionally, this mineral was observed to be concentrated within specific layers in the metasediments, suggesting that garnet growth was partially dependent upon bulk chemical characteristics of particular sedimentary beds. Potassic feldspar is entirely absent from the thin sections studied, a feature which characterizes greywackes generally, regardless of geological age (Pettijohn 1970, p.241). Sillimanite, observed in two localities typically occurs as euhedral to subhedral inclusions within biotite, as fibrous overgrowths of biotite and muscovite, and as individual needles within quartz. The fibrolite variety is also present, although far less abundant than the more coarsely crystalline sillimanite, and always occurs with biotite and muscovite. The bulk of sillimanite appears to have developed during prograde metamorphism.

The metamorphic mineral assemblages encountered in the detrital metasediments are tabulated below, with individual minerals listed in order of decreasing abundance:

plagioclase + quartz + biotite + garnet,
plagioclase + quartz + sillimanite + garnet,
plagioclase + quartz + biotite + muscovite + garnet,
plagioclase + quartz + hornblende, and
plagioclase + quartz + actinolite + biotite.

These assemblages developed under conditions of amphibolite facies regional metamorphism which at least locally attained sillimanite-almandine-muscovite subfacies rank. However, diagnostic minerals aiding in the subdivision of metamorphic facies within the English River Subprovince are usually lacking.

The metasandstones possibly originated as distal turbidite sequences deposited in a series of presently east-west oriented sedimentary basins. This tentative proposal is based on minimal field data, an absence of proximal conglomeratic facies, and occurrence of thin, albeit rare, bedded metagraywacke.

An interesting exposure containing faserkiesel[1] was observed near "Heart Attack" Lake, occurring as creamy-white, pencil-like aggregates of quartz-sillimanite (minor biotite and muscovite) within a narrow band approximately 15 cm in width (Photo 22). These aggregates which commonly measure 4 cm in length and 0.5 cm in diameter, define a strongly penetrative lineation, and con-

[1]Literally "fibrous pebble" and refers to small discoidal to irregular quartz-sillimanite segregations.

OGS 10 279

Photo 22–Individual and coalescing quartz-sillimanite faserkiesel as revealed on polished slab etched with hydrofluoric acid. Rock slab was sectioned approximately normal to the long axis of the faserkiesel. Bar is equal to 1 cm. Near "Heart Attack" Lake, English River Subprovince.

spicuously weather above a more easily disintegrated plagioclase-quartz-biotite matrix. In thin section it is notable that plagioclase is almost entirely absent from the faserkiesel. Biotite, when present, exhibits signs of degradation in the form of ragged grain boundaries, extensive overgrowth by sillimanite and mottled birefringence and pleochroism as contrasted against subhedral fresh biotite grains present in the matrix. Abundance of biotite is considerably lower within the faserkiesel. Halos of biotite and minor muscovite always occur contiguous to the faserkiesel perimeters.

Sillimanite grains range in form from coarsely crystalline needles and aggregates to very fine-grained fibrolite; the fibrolite is usually associated with biotite and muscovite. The individual needles and fibrolite mats display a strong preferred arrangement, parallel to the long axis of the faserkiesel. Losert (1968) ascribes these structures to a metamorphic differentiation process termed de-alkalization.

Geochemistry

Although the metasediments of the English River subprovince have generally undergone thorough metamorphic reconstitution and structural overprinting, bulk compositional characteristics as ascertained from two representative samples, compare quite favourably with numerous average greywackes of Early Precambrian (Archean) age (Table 15). Collectively, all the tabulated compositions display both a limited variation and relatively low abundance of FeO, Fe_2O_3, and MgO. This feature is corroborated by a relatively stable colour index. Also significant is the constancy of CaO and total alkalis. With one exception, all comparative rock groups indicate Na_2O in excess of K_2O, one of the major chemical attributes of greywacke (Pettijohn 1963, p.57). The Al_2O_3 contents in the survey samples also tend to be somewhat higher than usual.

IRON FORMATION

A salient feature of the English River Subprovince within the general map-area is a particular abundance of clastic magnetite-metagreywacke iron formation in proximity to the regionally curvilinear contact with the volcanic-rich Uchi Subprovince situated to the north. It is especially notable that both the continuity and total magnetic field intensity of the individual iron formation units (partially listed below) diminishes in a direction approximately normal to this subprovince boundary. Three prominent easterly trending iron formation bands obvious on aeromagnetic maps 942G, 932G, 952G (ODM-GSC 1960) were delineated both by previous exploration activity and the present survey:

(1) Lorenzo Lake-Sapwell Lake iron formation (21 km strike length),
(2) August Lake-Greenmantle Lake iron formation (26 km strike length), and
(3) "Heart Attack" Lake (local name)-Beavis Lake iron formation (32 km strike length).

The latter unit is traceable for an additional 16 km to Kilbarry Lake, east of the map-area. Several localized zones of the latter two iron formation units indicate total absolute field magnetic intensities exceeding 73 000 gammas. The iron formation at "Heart Attack" Lake ranges up to at least 180 m in thickness.

GRANITIC ROCKS

Widespread invasion of the fine-grained detrital metasediments and iron formation units by white massive leucocratic coarse-grained to pegmatitic granitic rocks is a characteristic feature of the English River Subprovince. The pegmatitic rocks, in particular, commonly occur as massive resistant knolls and ridges within more easily weathered metasedimentary host rocks. The composition of the granitic rocks varies considerably, as is indicated by feldspar staining on slabbed surfaces, ranging from true granite to trondhjemite,

TABLE 15 **CHEMICAL COMPARISON OF ENGLISH RIVER TYPE BIOTITIC QUARTZOFELDSPATHIC GNEISSES WITH AVERAGE PRECAMBRIAN GREYWACKE.**

Oxide	A	B	C	D	E	F
SiO_2	67.4	63.4	64.67	63.66	64.73	67.11
Al_2O_3	16.8	18.2	13.41	14.85	15.73	15.69
Fe_2O_3	0.43	0.56	1.24	1.01	0.91	1.23
FeO	3.94	4.75	4.53	4.67	4.60	3.56
MgO	1.93	2.95	3.23	2.99	2.56	2.02
CaO	3.87	3.78	3.04	2.63	2.83	3.17
Na_2O	3.34	3.49	2.99	3.14	2.69	2.75
K_2O	1.52	1.99	2.02	2.30	3.21	2.69
H_2O+	0.91	0.94	1.94	2.17	1.46	0.76
CO_2	0.15	0.10	-	1.49	-	-
TiO_2	0.45	0.58	0.57	0.57	0.51	0.43
P_2O_5	0.12	0.17	0.14	0.14	0.29	0.18
MnO	0.07	0.11	0.13	0.11	Included with FeO	Included with FeO
S	0.01	0.02	-	-	-	-
Total	101.0	101.2	100.26	99.99		
Total Alkalis	4.86	5.48	5.01	5.44	5.90	5.44
Trace Element						
Ag(s)	-	-				
As(c)	3	3				
Ba(S)	400	600				
Co(A)	15	20				
Cr(S)	40	130				
Cu(A)	20	20				
Ga(S)	20	20				
Li(S)	30	40				
Mo(S)	-	-				
Ni(A)	25	30				
Pb(S)	10	20				
Sb(C)	1	1				
Sc(S)	-	-				
Sr(S)	500	1200				
V(S)	20	150				
Y(S)	20	20				
Zn(A)	70	75				
Zr(S)	70	100				
Be(S)	3	-				
Sn(S)	-	-				

S = Emission spectroscopy.
A = Atomic absorption spectrophotometry.
C = Colorimetry.

A. Garnet-biotite-quartz-plagioclase metagreywacke, western end "Heart Attack" Lake. Analysis by Geoscience Laboratories, Ontario Geological Survey.
B. Gneissic biotite-garnet-quartz-plagioclase metagreywacke, north end of Finton Lake. Analysis by Geoscience Laboratories, Ontario Geological Survey.
C. Average of 12 Precambrian greywackes (Pettijohn 1963, p.57).
D. Average of 20 Archean greywackes (Henderson 1972).
E. Average of 28 metasediments, Manigotagan gneissic belt (McRitchie and Weber 1971, p.53)
F. Average of 39 English River gneissic belt metasediments (Dwibedi 1966).

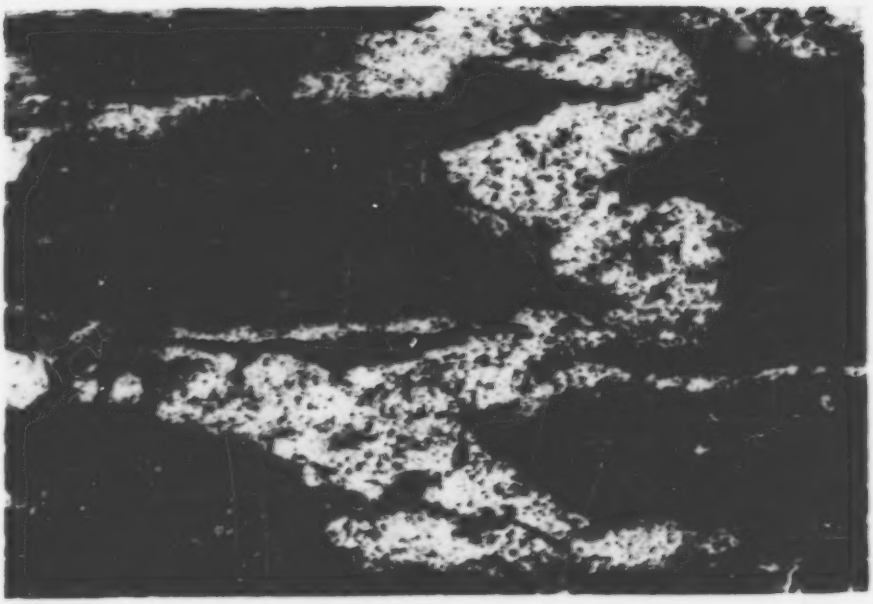

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Photo 23–Typical exposure of English River metasedimentary migmatite, about 1.5 km south of Murrell Lake.

and these rocks generally have a very low colour index (usually less than 5). Mineralogically, the granitic rocks consist of quartz, plagioclase, potassic feldspar, biotite, and muscovite with occasional accessory magnetite, tourmaline, apatite, and garnet. Plagioclase is frequently distinguishable in the field by a light lime-green colouration (fresh surface) possibly resultant upon saussuritization. Porcellaneous white coloured weathered surfaces are typical of these rocks.

Two distinct modes of occurrence for the granitic rocks are generally distinguishable:

(1) *Lit-par lit* to discordant narrow injections of coarse-grained granitic mobilizate (Photo 23).

(2) More extensive zones consisting predominantly of pegmatite, frequently laden with a variety of inclusions.

In the latter case, at least three types of inclusions are present:

(1) discrete relatively undistorted blocks of typical English River Subprovince metasedimentary rock;

(2) blocks of garnetiferous amphibolite; and

(3) schlieren and local clots of mafic material.

The granitic intrusive masses are interpreted by the writer to have originated by partial fusion of the older biotite-quartz-plagioclase metasedimentary host rocks during upper amphibolite facies regional metamorphism. The composition of an anatectic granitic mobilizate is dependent upon many factors such as P_{H_2O}, Ab/An ratio of source rock, and temperature at the commencement of minimum melting (Winkler 1970). Variation in an interplay of these factors probably resulted in the qualitatively observed wide variation of K-feldspar/total feldspar ratios. The biotite-hornblende clots and schlieren probably represent the incongruently reacted residua or restite of the anatectic process.

Economic Geology

Mineral exploration within the English River Subprovince has been directed exclusively towards the prominent clastic magnetite-metagreywacke iron formations. Such exploration was greatly facilitated by release of the federal-provincial aeromagnetic map series in 1960. Over the past fourteen years, virtually every potentially important iron formation has received exploration attention, most notably by The Algoma Steel Corporation Limited.

PROPERTY DESCRIPTIONS

"Heart Attack" Lake Iron Prospect

History. In 1962, Nordex Mining Limited conducted a ground magnetic survey (Sharpe A-2 Magnetometer) over 29 unsurveyed claims of W. Arrowsmith, between "Heart Attack" Lake (local name) and "Wolf" Lake (local name). Survey lines totalling 30.2 km outlined a west to southwest trending magnetite iron formation zone approximately 3300 m in length and varying in width from 90 m to 300 m (File 63.1170, Assessment Files Research Office, Ontario Geological Survey, Toronto). Considerable trenching, and pitting was undertaken and seven diamond drill holes totalling 289 m were drilled at this time (Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay).

The Arrowsmith claim-group apparently lapsed and was acquired by T.A. Gustafson of Thunder Bay. The Algoma Steel Corporation Limited optioned the 21 claim property in 1966 (File 63.2143, Assessment Files Research Office, Ontario Geological Survey, Toronto). A ground magnetic survey over 21 km of line utilizing a McPhar M-500 Fluxgate Magnetometer more definitely outlined the magnetic zone vis-a-vis the previous survey:

> Zone One: 480 m long, average width of 150 m (500 feet) with a magnetic intensity of 74 000 gammas;
>
> Zone Two: 730 m long, average width of 45 m with a magnetic intensity of 80 000 gammas.

Considerable diamond drilling amassed during 1966 to 1967 (26 holes to-

talling 4283 m) appears to have outlined an ore deposit of potential economic significance (Regional Geologist's Files, Ontario Ministry of Natural Resources, Thunder Bay.) No tonnage figures have been indicated to date. The magnetite to greywacke ratio within the iron formation intersection in diamond drill logs was also not disclosed.

The Algoma Steel Corporation Limited also investigated other iron formations by ground magnetic surveys and diamond drilling during 1967 and 1968 in the Beavis Lake area (eight holes totalling 830 m) and August Lake area (four holes totalling 547 m) (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Geology. A brief examination was made of this property. Access is exclusively by float-equipped fixed wing aircraft via nearby "Wolf" Lake. At the western end of this lake a short drill road permits direct access to the majority of exposures. Best exposures occur along the southern shore of "Heart Attack" Lake.

The area of interest lies at the western end of the west to southwest trending "Heart Attack" Lake-Beavis Lake iron formation. Airborne total field magnetic intensities exceed 73 000 gammas in vicinity of the deposit (Map 942G, ODM-GSC 1960). Host rocks of the iron deposit are predominantly fine-grained, foliated garnetiferous biotite metagreywacke. Thinly developed bedding is locally apparent, characterized by alternation of beds in the order of 5 mm thickness which display variation in biotite content from less than 1 percent to 15 percent, respectively corresponding to arkose and greywacke bulk compositions. Major and trace element analyses of a bulk sample of the metagreywacke is given in Table 15 (Sample A).

Basically, two types of iron formation can be classified at the outcrop scale:

(1) massive, essentially uniform sections of light to medium smokey grey (weathered surface) iron formation with clastic quartz and plagioclase usually uniformly dispersed amongst the dominant magnetite grains; and,

(2) conspicuously banded, relatively leaner iron formation, characterized by alternating black to smokey grey (weathered surface) magnetite-rich and light brown to light grey weathering magnetite-bearing mesobands[1] of garnetiferous metagreywacke.

The former locally possess thin mesobands of magnetite-bearing metagreywacke (Photo 24). In the latter, there does not appear to be any uniformity in mesoband widths or spacings but within some of the magnetite-rich mesobands, numerous laminations of very fine-grained magnetite, appear to be rhythmically spaced. Mineralogically, the iron-rich bands consist essentially of magnetite, quartz and plagioclase accompanied by variable, lesser amounts of hematite, chlorite, biotite and garnet. Along some bedding planes, in the massive sections of iron formation, relatively coarse biotite is especially conspicuous.

Towards the eastern end of "Heart Attack" Lake massive to banded iron formation was observed over at least a 180 m width. A composite 22 kg bulk

[1]Terminology after Trendall (1973).

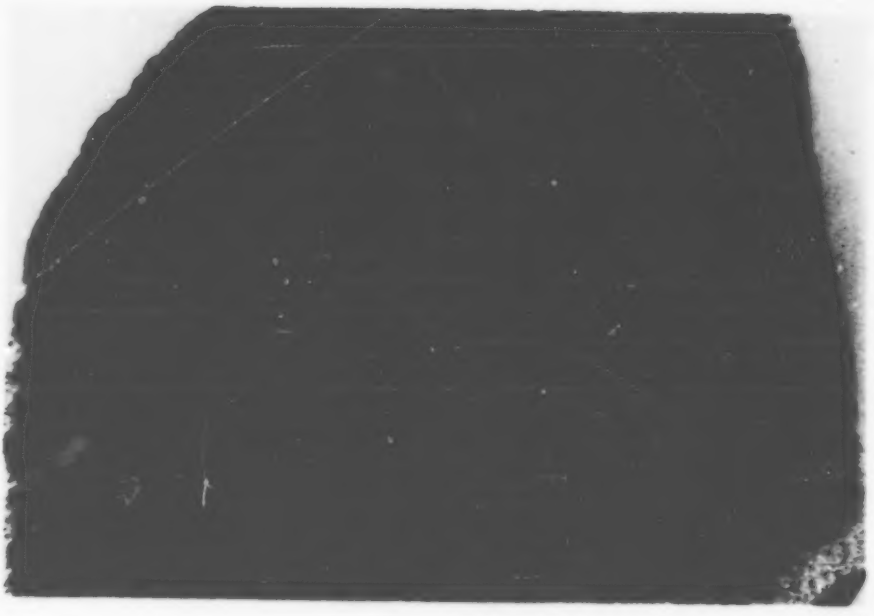

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Photo 24–Mesoband of laminated fine-grained magnetite iron formation intercalated with magnetite-bearing biotite metagreywacke. A thin epidote veinlet traverses across the central part of the sample. Photograph of polished slab etched with hydrofluoric acid. Bar indicates 1 cm length. South shore of "Heart Attack" Lake, English River Subprovince.

sample selected by the writer at 30 cm intervals along a 4.5 m trench normal to the structural trend and considered to be representative of a typical high grade section was analyzed for major and trace elements (Table 16) by the Geoscience Laboratories, Ontario Geological Survey.

The whole area has been pervasively injected by *lit-par-lit* and discordant xenolith-bearing masses of coarse-grained to pegmatitic granitic rocks. There appears to be two types of pegmatitic rocks:

1) relatively early, more extensive, massive, white (fresh surface), leucocratic muscovite-quartz-feldspar type, and,

2) a later, massive, pink (fresh surface), leucocratic biotite-quartz-feldspar variety.

The former are identical to granitic intrusions found elsewhere in the English River Subprovince and always exhibit an intimate, possibly anatectic association with the garnet-biotite metagreywacke. The relative abundance of these rocks would appear to detrimentally affect ore reserve calculations.

TABLE 16 | MAJOR AND TRACE ELEMENT ANALYSIS OF THE "HEART ATTACK" LAKE IRON FORMATION[1].

Major Elements[2]		Trace Elements[3]		
SiO_2	43.7	As	3	(C)
Al_2O_3	6.15	Ba	400	(S)
Fe_2O_3	33.4	Be	5	(S)
FeO	8.89	Co	15	(A)
MgO	2.40	Cr	50	(S)
CaO	1.00	Cu	15	(A)
Na_2O	1.17	Ga	10	(S)
K_2O	1.50	Li	50	(S)
H_2O+	0.60	Mo	10	(S)
H_2O-	0.14	Ni	20	(A)
CO_2	0.10	Pb	10	(S)
TiO_2	0.22	Sb	4	(C)
P_2O_5	0.23	Sr	250	(S)
S	0.01	V	10	(S)
MnO	0.05	Zn	30	(A)
TOTAL	99.6	Zr	50	(S)
TOTAL Fe	31.2			

1. 22 kg chip sample, collected at 30 cm intervals across formation.
2. in weight percent oxide
3. in p.p.m.
S = Emission Spectroscopy
C = Colorimetric
A = Atomic Absorption
Analysis by Geoscience Laboratories, Ontario Geological Survey.

Structure. The thinly bedded type of iron formation is locally contorted into S-type flowage folds having a variable inter-limb angle. The axial planes are essentially vertical with fold axes plunging steeply towards the east. Possible graded bedding is obvious in several of the magnetite-bearing metagreywacke mesobands defined by a decrease in grain size of isolated mesoscopic magnetite grains although it is unknown to what extent size and shape of these grains have been influenced by metamorphism. Rare clastic dikes of magnetite-bearing metagreywacke inject into magnetite-rich mesobands at low angles to bedding (Photo 25). These structures are not uncommon in distal turbidite sequences (K.D. Card, formerly Geologist, Ontario Geological Survey, personal communication). Several small quartzofeldspathic clasts are occasionally apparent, with contiguous bedding planes slightly deflected around such fragments. These clasts likely originated as exotic fragments rafted in by turbidity currents.

OGS 10 282

Photo 25–Clastic dike of metagreywacke invading a mesoband of fine-grained, laminated magnetite iron formation. A relatively late fault has effected minor displacement along the right side of the photograph. Length of bar equal to 1 cm. South shore of "Heart Attack" Lake.

Origin of Iron Formation. The iron formation at "Heart Attack" Lake in addition to others occurring in the English River Subprovince as well as in the nearby Wabigoon Subprovince as exemplified in the Savant Lake area (Bond 1977) and in the Geraldton area (Pye 1952) apparently differ from iron formation occurring elsewhere in the Superior Province in a notable absence of chert and a definite clastic association. The magnetite in these formations possibly originated via erosion of previously deposited "primary" exhalative chert-magnetite iron formation within a proximal island-arc system (Hutchinson *et al.* 1971, p.5). Deposition of the "Heart Attack" Lake iron formation deposit is believed by the writers to have been effected by turbidity currents transporting detrital magnetite and volcanogenic debris of greywacke bulk composition to relatively quiescent flanks of an extensive eugeosyncline.

Two regional observations provide some support for this interpretation:

(1) magnetite-chert volcanogenic iron formation is particularly well developed and persistent within the nearby Pashkokogan Lake-Misehkow River metavolcanic-metasedimentary belt, and

(2) magnetite-greywacke iron formation is similarly extensively devel-

oped and persistent (in terms of strike length) on a regional scale along the northern boundary of the English River Subprovince in the Greenbush Lake-Kilbarry Lake area. The individual iron formations also display a strong tendency to diminish in magnetic intensity and continuity in a direction approximately normal to the regional boundary between the Uchi and English River Subprovinces.

The second observation implies a relative diminution of supply of detrital magnetite at progressively greater distances from the Uchi Lake Subprovince magnetite-chert iron formation.

This interpretation assumes a gross contemporaneity in the existence of an island-arc volcanic pile in the Uchi Lake Subprovince and of the adjacent English River Subprovince sedimentary trough, although stratigraphic relations between the Uchi Lake and English River Subprovinces are presently unclear and controversial.

Early Tectonic to Syntectonic Granitic Rocks

Due to a lack of reliable geochronological age determinations and little detailed knowledge on the structural history of granitic rocks of the report area, pretectonic to syntectonic granitic rocks could not be effectively subdivided from those of a syntectonic to late-tectonic derivation. The only rocks that could confidently be assigned to the pretectonic grouping are the quartz-feldspar porphyry intrusions which are comagmatic with the volcanism. Various plutonic masses described under the ensuing section "Syntectonic to Late Tectonic Granitic Rocks" may in fact be ultimately re-assigned to that group intruded prior to the Kenoran thermal-tectonic event at about 2.7 billion years.

Syntectonic to Late Tectonic Granitic Rocks

Felsic to intermediate intrusive granitic rocks underlie approximately 70 percent of the map-area, ranging in composition from granite (senso stricto) to diorite. In general, these diverse rocks occur in two distinctive and obvious geological settings, as is the case elsewhere in the Uchi Lake and Gods Lake Subprovinces of the Superior Province:

(1) extensive granitic complexes predominantly of batholithic dimensions positioned between anastomosing metavolcanic-rich belts, and,

(2) discrete, relatively diminutive intrametavolcanic belt plutonic complexes, of stock to small batholith dimensions.

The former category is difficult to accurately subdivide on a reconnaissance basis although several regionally distinctive major granitic rock units were delineated as a result of this survey. Examination of the widespread inter-belt granitic complexes was almost exclusively restricted to numerous, brief, helicopter-supported investigations, predominantly by the senior members of the mapping parties. A few critical localities received more extended examination. The intra-belt stocks were generally examined in more detail during the course of ground and lakeshore mapping.

Many hand-specimens were slabbed with a portable diamond saw and stained for feldspar using hydrofluoric acid, and sodium cobaltinitrite according to methods described by Bailey and Stevens (1960) and Boone and Wheeler (1968). This facilitated rapid visual categorization of the granitic rock types utilizating the classification parameters of Ayres (1972). Textural terms utilized in describing these rocks were taken from Williams *et al.* (1954) and Spry (1969). Virtually all the major granitic units examined exhibit magnetic characteristics. Sharp discordant contacts, chilled contacts, prevalent felsic to mafic xenoliths, and structural discordancies collectively comprise such evidence.

INTERBELT BATHOLITHIC COMPLEXES

Carling Granite

The Carling Granite, named by Clifford (1969, p.35) forms a large batholithic mass completely enveloped by supracrustal belts described in this report It is elongated in an east-west direction, measuring about 60 km in this direction and has an average breadth of approximately 20 km. Clifford (1969, p.35) described this granitic mass as a "massive biotite-plagioclase-orthoclase-quartz rock" predominantly pink, and characterized by a xenolith population of pelitic metasedimentary and/or mafic plutonic material.

Cat Lake-Williams Lake Batholithic Complex

Examination of both regional compilation and detailed aeromagnetic maps flown under a joint federal-provincial sponsorship during 1959 and 1960 reveals several distinctive regional magnetic subdivisions within the map-area. Foremost is an extensive, crudely rectangular area of relatively high magnetic intensity and amplitude which is centered approximately at Latitude 51°45′ and Longitude 90°40′, near Williams Lake. This area is characterized by very distinctive magnetic patterns consisting of innumerable, generally easterly to northeasterly oriented densely spaced local nodes and basins resembling the "wood-grain pattern of bird's eye maple" which Kornick (1971 , p.52) used to describe the magnetic pattern observed over granulitic rocks occurring in the Superior Province east of Thompson, Manitoba. Local magnetic relief typically varies between 500 and 1000 gammas total absolute field, attaining a maximum value of 3940 gammas 10 km northwest of Mamiegowish Lake (Map 924G, ODM-GSC 1960). This distinct magnetic zone is strongly associated with a vast area underlain principally by massive porphyritic to equigranular potassic granitic rocks locally varying in magnetite content. The area as outlined on Figure 2 may possibly represent a narrow easterly lobate extension from the main mass of the Berens River Block, which rapidly widens west of Longitude 92°30′. This large batholithic complex extends for a distance of 135 km from the west-central map-area limits at Cat Lake easterly to the Spruce River-Menako

Lakes region with average widths of about 50 km. Along Longitude 90°30′ the complex reaches a maximum breadth of 70 km.

The southern and southeastern margins, as approximately marked by a line joining Wettlaufer, Leckey, and Massia Lakes, are particularly well defined magnetically, contrasting strikingly with the generally expressionless, low amplitude magnetic intensity pattern characterizing the Dobie Lake trondhjemitic batholith situated to the south (ODM-GSC 1970a). To the west, the batholithic complex intrudes the Lang Lake metavolcanic-metasedimentary belt and extends westwards out of the map-area. East of Massia Lake, the contact is defined by a curvilinear lineament interconnecting Massia, Trebell, and Kibler Lakes. In this area, the easterly trending magnetic nodes abruptly truncate strong northeasterly magnetic trends of a narrow zone of early, grey, well foliated, leucocratic to melanocratic, biotite and hornblende-biotite trondhjemite. This narrow zone, in which foliate structures trend northeast, averages 5 km in width and extends approximately from the southeastern end of Kibler Lake northeasterly towards the confluence of the Spruce and Otoskwin Rivers before expanding outwards towards the east in the form of batholithic masses.

Strong curvilinear structural control of Menako, Spruce and Obustiga Lakes possibly marks the northeastern contact, although such a discontinuity is not readily recognized on aeromagnetic maps 926G, 924G, and 934G (ODM-GSC 1960). An adjacent area, approximately bounded by Pikotowug, Totogan, Brock and Menako Lakes is subtly distinguished by a very strong northeasterly magnetic trend composed of generally more continuous and less intensive magnetic highs. Exposures along the contact zone are rather limited being largely covered by glacial materials of the Agutua Moraine. A few helicopter visits indicated an absence of porphyritic potassic granitic rocks which typify the nearby Cat Lake-Williams Lake batholithic complex.

The meandering northern contact, which closely follows Latitude 52°00′ between Kinloch Lake and Whitestone Lake, is largely deduced from aeromagnetic maps 926G, 916G, 924G, 906G, 896G, 894G, 904G, and 914G (ODM-GSC 1960). West of a line joining Maika and Whitestone lakes, the magnetic pattern is rather directionless and low in amplitude, somewhat similar to that of the Dobie Lake batholith. Nevertheless porphyritic potassic rocks continue to persist in this region, extending to the western limits of the map-area at Longitude 92°00′.

Lithology

The Cat Lake-Williams Lake batholithic complex as outlined by the present survey, is composed of an overwhelming abundance of porphyritic potassic granitic rocks, as confirmed by extensive feldspar staining on slabbed hand specimens and by major element chemical analyses (Appendix A, analyses HAK8-3 and HAK8-4). Megascopic studies, aided with a binocular microscope constituted the primary means of studying these rocks since the prevailing coarse grain size greatly hampers thin section microscopy.

Although numerous granitic phases are present, the predominant rock type consists of coarse-grained, massive to weakly foliated, porphyritic biotite

and hornblende-biotite quartz monzonite to granodiorite. In certain instances biotite-hornblende porphyritic phases are present. Considerable variation with regard to colour index, size and abundance of potassic-feldspar phenocrysts is notable. Abundance of visible quartz, usually 25 to 30 percent constitutes an additional characteristic feature. Fresh surface colours commonly vary from pinkish grey to bright brick orange. Euhedral to subhedral potassic feldspar phenocrysts which comprise up to 30 percent of the rock occasionally display well-developed zonation on slabbed surfaces. Seriate textures are particularly commonplace with the size of potassic feldspar phenocrysts progressively grading from typical length of 2 to 3 cm down to matrix grain sizes on the order of 4 to 5 mm. The largest phenocryst observed by this survey measured 5 cm in length. Colour of these phenocrysts varies from light grey to deep brick orange, depending upon the quantity of microcrystalline hematite contained within crystal structure. These phenocrysts appear to have crystallized relatively early under magmatic conditions as indicated by common presence of crystal faces, zonation and almost total lack of poikilitic inclusions other than erratic grains of earlier formed minor accessory minerals. Igneous platy-flow foliations are widespread and evidenced by trachytic alignment of phenocrysts and preferred orientation of xenoliths. A later generation potassic feldspar is occasionally present in the matrix, occurring as irregular interstitial, inclusion-rich stringers and blebs. Matrix of these rocks is medium to coarse grained and dominated by a hypidiormorphic- to allotriomorphic-granular aggregation of plagioclase, quartz, and ferromagnesian minerals. Creamy white to faintly pink plagioclase very rarely attains dimensions of the potassic feldspar phenocrysts.

Colour index of the porphyritic phase ranges from 2 to 30 corresponding to a general concomitant decrease in visible quartz abundance. Usually colour index is less than 10. Biotite is the most abundant and prevalent characteristic accessory, although appreciable amounts of hornblende occur in rocks with relatively high colour index and low quartz contents. Magnetite, sphene, apatite, and garnet, represent the minor accessory minerals listed in order of approximate decreasing abundance. The abundance of magnetite varies appreciably (up to 10 percent) and generally is directly proportional to colour index, as qualitatively determined by the degree to which a suspended hand magnet is attracted to hand specimens of approximately similar size. Sphene is often altered to crumbly straw-yellow coloured material, possibly caused by radioactive disintegration.

Subordinate rock types occurring in the Cat Lake-Williams Lake batholithic complex include ubiquitous massive equigranular granitic dikes (described below under "Late Granitic Phases") and widespread local masses and xenoliths of foliated leucocratic biotite trondhjemite. The latter are very similar to rocks occurring in the Dobie Lake batholith and in the area north of Biznar Lake flanking the Cat Lake-Williams Lake batholithic complex. The relatively massive nature of the extensive porphyritic terrain and presence of trondhjemitic inclusions implies a younger geological age for the porphyritic rocks.

MORRIS LAKE PLUTON

In the Morris Lake-Redpath Lake area, a small granitic stock is outlined by a conspicuous oblate-shaped aeromagnetic anomaly measuring 13 km in length and 10 km in breadth. Magnetic intensities vary up to and locally exceed 64 000 gammas absolute total field (Maps 904G and 905G, ODM-GSC 1960). The major rock type is massive porphyritic hornblende-biotite and biotite quartz monzonite, similar to that occurring in the surrounding area. A representative stained hand specimen from Redpath Lake was visually estimated to contain the following minerals: plagioclase 35 percent, potassic feldspar 35 percent, quartz 15 percent, biotite 10 percent, hornblende 2 percent, and sphene 1 percent. Colour index commonly varies between 10 and 20. Only rarely does hornblende represent the dominant mafic component.

The Morris Lake pluton possibly originated as a relatively late stage phase, consanguinous with or post-dating regional emplacement of the surrounding porphyritic potassic Cat Lake-Williams Lake granitic mass.

A striking difference in trends of the metavolcanic and metasedimentary belts in the Uchi Subprovince and the Gods Lake Subprovince has been realized for many years, although the nature of the fundamental boundary between these subprovinces has continued to remain unresolved both within the map-area and to the east (Riley *et al.* 1971, p.7). Wilson (1971, p.45) has speculated that the Berens River Subprovince extends through the map-area as a granitic area containing a marked paucity of preserved 'greenstone'. This zone is remarkably coincident with a similarly trending relatively high negative Bouguer gravity anomaly (– 45 mgals) as shown by Wilson (1971, p.45).

LATE GRANITIC PHASES

A universal characteristic of the extensive granitic terrain is the presence of a relatively late intrusive phase consisting of massive, equigranular, fine- to medium-grained biotite granite to quartz monzonite, principally occurring in swarms of narrow dikes and local masses. Such rock types are abundant in the northwestern and west-central portions of the map-area, particularly in association with the porphyritic potassic rocks of the Cat Lake-Williams Lake batholithic complex. In hand specimens these rocks are highly leucocratic (colour index less than 5), with hypidiomorphic-granular textures commonplace. Weathered surfaces are distinctively brownish red to brick red. Biotite is the sole mafic mineral present. Contacts with host granitic rocks are invariably sharp and frequently display chilling effects. Inclusions are relatively sparse and usually are angular. Frequently, younger possibly consanguinous pink pegmatite dikelets and masses occur, intimately associated with this granitic phase. These rocks possibly originated as late-tectonic apophyses, derived from plutonic centers of similar composition. In the Kishikas Lake area, a circular stock containing quartz monzonite very similar in appearance to the dike rocks was delineated by the present survey. It appears most likely that these rocks are related to an intrusive event of regional extent because of their prevalence over a wide area. In terms of bulk composition and abundance, and intimate

association with the Cat Lake-Williams Lake batholithic complex it would appear reasonable to regard these rocks as a late intrusive phase of this batholith. Emplacement appears to have been in part guided by previous brittle-failure of the host rocks.

Dobie Lake Batholith

This large elongate batholithic complex (approximately 1040 km²) is situated north of the coalescing Meen-Dempster Lakes and Dempster-Pickle Lakes belts, embodying maximum dimensions of 71 km long and 27 km wide. The complex is readily distinguishable, aeromagnetically, by virtue of a pronounced lack of magnetic expression and trend (60 700 gammas average total field intensity and 560 gammas relief), vis-a-vis the aforementioned volcanic belts (including the Lang Lake belt) and the large extensive area of abundant magnetic porphyritic granitic rocks which characterize the Cat Lake-Williams Lake batholithic complex situated along most of the northern contacts (Maps 903G, 904G, 905G, 913G, 914G, 915G, 923G, 924G, ODM-GSC 1960).

A brief study of this batholith entailed slab cutting and feldspar staining of 21 hand specimens collected from uniformly distributed helicopter stops. An overwhelming dominance of various light to medium grey (fresh surface) trondhjemitic rocks is the most notable feature. The rocks examined represent several phases, generally incorporating the following attributes:

(1) massive to weakly foliated, occasionally gneissic,
(2) medium- to coarse-grained,
(3) predominantly recrystallized,
(4) leucocratic (colour index invariably 10 or less),
(5) biotite as characteristic mafic accessory mineral, hornblende is very rare, and
(6) a marked paucity of potassic feldspar.

A visually estimated mode on a specimen collected near the central portion of the batholith, (2.4 km east of Strout Lake) and judged to be representative is plagioclase 65 percent, quartz 30 percent, biotite 3 percent, potassic feldspar 1 percent, and magnetite less than 1 percent.

The textures are predominantly equigranular, hypidiomorphic-granular to granoblastic-interlobate, depending upon completeness of recrystallization and intensity of foliate structures. Generally, granoblastic textures predominate, made apparent by polygonization of single crystals of quartz and suturing and attrition of primary igneous crystal faces of plagioclase by metamorphic overgrowths of adjacent mineral phases and development of foliate structures. Porphyritic phases are locally present characterized by massive to flow oriented, blocky and elongate plagioclase phenocrysts ranging up to 15 mm in length embedded in a groundmass averaging 4 to 6 mm average grain size. Oscillatory zoning was recognized within subhedral plagioclase crystals in one hand specimen. Potassic feldspar, when present, always occurs as interstitial, diminutive, sparsely scattered grains.

Dikes of light pink (fresh surface) leucocratic biotite quartz monzonite are particularly common along the northern margins of the Dobie Lake batholith, adjacent to the Berens River block.

INTRABELT PLUTONIC COMPLEXES

Numerous granitic stocks and small batholiths are completely enclosed by supracrustal rocks within the survey area. The plutonic complexes investigated, as listed below, have been formally named in order to facilitate referencing:

Doran Lake Stock,
Duffell Lake Stock,
Graniteboss Lake Stock,
Hooker-Burkoski Stock,
Kawashe Lake Stock,
Obaskaka Lake Batholith,
Ochig Lake Batholith,
Pickle Lake Stock, and
Webb Lake Stock.

A large exposure of massive medium-grained, melanocratic, equigranular, grey (weathered surface) quartz diorite occurs on a lake approximately 0.8 km south of Osnaburgh Lake. In thin section, the rock was visually estimated to contain 50-65 percent hornblende, 10-15 percent quartz, 35-45 percent plagioclase of andesine composition, and minor magnetite. Quartz and plagioclase occur in an interstitial mosaic to the hornblende. Hornblende is usually slightly poikilitic with diminutive (0.01 mm) felsic grains. The immediate area near the above outcrop as well as between Caron and Frain Lake lacks aeromagnetic features generally characteristic of metavolcanic-metasedimentary rocks and appears to suggest the presence of an east-west trending granitic mass of stock dimensions (Map 922G, ODM-GSC 1960). Alternatively, this aeromagnetic pattern could represent a volcanic-sedimentary rock assemblage of low metamorphic grade, similar to the magnetic pattern characteristic of the central portion of the Pickle Lake belt, southwest of July Falls (File 2.544, Assessment Files Research Office, Ontario Geological Survey, Toronto). One circumstantial source of data in favour of the presence of granitic rocks in the Caron-Frain Lakes area, is indicated by the complete lack of strong sulphide-bearing electromagnetic conductors within the inferred granitic area, and their relative commonness in the immediate area of known volcanic-sedimentary rocks, as supported by the extensive recent diamond drilling programs of numerous exploration companies.

Doran Lake Stock

This oblate-shaped pluton (105 km^2) is the largest granitic body intruding the Lake St. Joseph metavolcanic-metasedimentary belt. Where observed, the rocks are principally massive, light pinkish grey (fresh surface) coarse-grained porphyritic quartz monzonite with potassic feldspar phenocrysts up to 20 mm in length. The mafic minerals are biotite and hornblende with the latter being dominant. Angular to subrounded mafic metavolcanic xenoliths of varying size occur scattered along northern margins of the stock.

Duffell Lake Stock

Best exposures of this small stock, which intrudes the Pickle-Dempster Lakes belt, lie at the western end of Duffell Lake, and consist of massive, homogeneous, very coarse grained (average grain size 8 mm), leucocratic, equigranular biotite quartz monzonite. Weathered surfaces vary from porcellaneous white to light pink. Visual estimation of mineral abundances on a stained surface revealed the following: plagioclase 35 percent, potassic feldspar 30 percent, quartz 30 percent, and biotite 5 percent. Interpretation, primarily based upon aeromagnetic information (Map 913G, ODM-GSC 1960) suggests an east-trending crudely elliptical shape, indented by metavolcanics at both ends. In thin section, hypidiomorphic-granular textures prevail, with evidence of incipient recrystallization of quartz. Plagioclase is typically altered to very fine grained indeterminate masses (argillic) which are usually confined to the plagioclase cores. Oscillatory zonation is made apparent by the pattern of the alteration in some plagioclase crystals. Very small grains of myrmekitic plagioclase were noted. Quartz grains achieve maximum grain diameter of about 10 mm. In thin section many examples of incomplete recrystallization of original single grains were observed. These exhibit a transition of the central portion of the original grain now characterized by strong deformational banding and development of a ragged subgrain network, to an outer margin consisting of a completely recrystallized polygonal aggregate of relatively strain free grains. Perthitic microcline appears as a relatively late mineral phase, engulfing all other major minerals. Accessory minerals include euhedral sphene, epidote, and sericite.

Graniteboss Lake Stock

The north-trending Graniteboss Lake stock, is a small bulbous pluton (13 km^2) exposed along the southern half of Graniteboss Lake and completely enclosing Mousetrap Lake. The long axis of the stock partially attenuates structural trends within the Meen-Dempster Lakes belt. Principally, the rocks are massive, medium-grained, homogeneous, equigranular to leucocratic, orange-pink (fresh surface), quartz poor (10-15 percent), biotite-hornblende quartz monzonite. Locally, as the quartz content decreases and colour index increased to 20, these rocks grade into monzonite and syenodiorite. A stained specimen from Mousetrap Lake revealed the following visually estimated mode: plagioclase 40 percent, potassic feldspar 30 percent, quartz 12 percent, hornblende 18 percent, and biotite 1 percent. Porphyritic textures are locally apparent as exemplified by an exposure of syenodiorite situated towards the southern end of Graniteboss Lake. Here, light pink (fresh surface), blocky, ovoid to lath-shaped plagioclase phenocrysts achieve a maximum length of 12 mm within a medium-grained matrix.

In thin section excellent hypidiomorphic-granular textures are preserved. Euhedral to subhedral plagioclase displays the effects of mild very fine grained light-brown alteration (argillic?). Well preserved oscillatory zoning is wide-

spread. Microcline appears to have developed as a relatively late interstitial phase. Euhedral plagioclase (andesine) crystals are often found engulfed in this mineral. There appears to be no evidence of recrystallization. All mineral phases evidence smooth interphase grain boundaries. Quartz, the most sensitive mineral to recrystallization, shows only weak undulose extinction. Hornblende, the principal mafic mineral, is light brown to light grass green in pleochroism. Local alteration to epidote and chlorite is present. Subhedral to euhedral sphene is a characteristic minor accessory mineral. Trace amounts of zircon and relict pyroxene were also observed.

The Graniteboss Lake stock is interpreted as a middle to upper mesozonal, late tectonic diapiric pluton, based upon homogeneity, lack of consanguineous pegmatitic phases, partial disruption of host rock structural trend, and nonrecrystallized character of the mineral assemblage.

Jackpine Lake Stock

Granitic rocks of the Jackpine Lake stock are exposed in scattered outcrops within Jackpine Lake. Similar rocks are found outside an arcuate band of amphibolite which is prominently outlined in airphotos, and are also found in xenoliths in the far northwestern corner of Zionz Lake.

In outcrop, the rock is light pink on weathered surface, leucocratic, gneissic, fine to medium grained (1 to 2 mm), equigranular and has a pronounced sacchroidal texture. On fresh surface it is a very pale pink to light pink. In thin section the rock is seen to be equigranular and allotriomorphic to hypidiomorphic. Texture is a mosaic texture of recrystallized quartz and feldspar (decussate to granoblastic, Spry 1969, p.187). Biotite is the only euhedral mineral and is concentrated in bands which give the rock its gneissic appearance in outcrop. Visual estimates of mode are microcline 10-15 percent, plagioclase of oligoclase to andesine composition 50-60 percent, quartz 30-35 percent, and biotite 5-10 percent. The rock is granodiorite in bulk composition.

The true paragenesis of the rock is in some doubt and its distribution ill-defined. The prominent banded nature in outcrop could be interpreted as relict bedding and hence the rock could represent a thick metamorphosed sequence of arkosic sediments. Metasediments were positively identified along the north shore of Zionz Lake and are possibly in contact with this lithologic unit. The presence of the amphibolite unit, most likely of mafic to intermediate volcanic origin, suggests that a volcanic environment existed at one time and that the rocks could represent a thick sequence of recrystallized felsic tuffs of rhyodacite composition. Scattered grains of plagioclase displaying good zoning are suggestive of igneous origin. To the authors, an igneous origin appears most probable even though additional work may alter this interpreration.

In the northwest area of Zionz Lake, blocks of this rock type were observed as xenoliths in granitic rocks thought to be related to the granitic batholith of the Zionz Lake area. This observation suggests that this rock type formed early in the sequence of geologic events. The surrounding granitic rocks display typical igneous granitic textures in outcrop and do not appear to be metamorphosed

or recrystallized. Excluding the biotite, the texture would be described as aplitic. To the west, adjacent to the map-area, previous mapping by Donaldson (1960) indicated massive, fine- to medium-grained, pink, leucocratic granite and granodiorite.

Kawashe Lake Stock

The Kawashe Lake stock intrudes mafic metavolcanics of the Meen-Dempster Lakes belt, covering an approximate surface area of 3.1 km^2. On weathered surface the rock is light pink to grey pink and appears massive, equigranular, and medium grained. On fresh surface the rock is dark pink to light red. In thin-section the rock is seen to be fine- to medium-grained, inequigranular (seriate) hypidiomorphic. A visual estimate of the mode reveals 45-55 percent plagioclase of oligoclase to andesine composition, 25-35 percent quartz, 10 percent biotite, less than 5 percent microcline and a trace of chlorite. The plagioclase ranges in grain size from large (3-4 mm) euhedral crystals to fine-grained interstitial anhedral crystals. The large crystals display a well developed oscillatory zoning which is particularly well enhanced by concentric zones of zoisite-sericite alteration which readily outline the zoned nature of the crystals. The microcline occurs as tiny interstitial anhedral grains displaying well developed quadrille twinning. The larger grains of quartz display a weak to moderate wavy extinction.

A second thin section was prepared from a granitic sample taken from close to the contact with the metavolcanic belt and displayed characteristic features of cataclasis. No euhedral mineral grains were noted as the rock consists of large oblate altered grains of plagioclase feldspar of andesine composition separated by much finer grained mosaic of recrystallized quartz displaying wavy extinction. Sericite, zoisite, and chlorite are common alteration minerals. A trace of zircon, carbonate and sphene were noted. Minor amphibole is present. The rock close to the contact appears to be a highly sheared trondhjemite and suggests that the contact between the stock and supracrustal rocks has been the site of tectonism probably related to its emplacement.

Hooker-Burkoski Stock

This stock, named by Pye (1956, p.38), was partially covered by the former claim group of Messrs. Hooker and Burkoski (Thompson 1939, p.16,17), situated approximately 2.4 km southeast of Central Patricia. Although the present survey did not examine this small pluton (approximately 20 km^2), a short description is contained within Pye's report.

Pye (1956) stated that the rocks are massive, fine to medium grained, brownish grey and dominantly equigranular, except near the margins where "...large feldspar individuals become evident, not only in thin sections but in hand specimens as well". An analysis of the rock given by Pye (1956, p.39) is given in Table 17. Important features of this analysis are the very low abun-

TABLE 17 MAJOR ELEMENT ANALYSIS OF ALBITE TRONDHJEMITE FROM THE HOOKER-BURKOSKI STOCK.

SiO_2	72.75
Al_2O_3	15.67
Fe_2O_3	0.42
FeO	1.27
MgO	0.47
CaO	0.35
Na_2O	6.54
K_2O	1.54
H_2O+	0.44
H_2O-	0.22
CO_2	0.33
TiO_2	0.22
V_2O_3	0.004
P_2O_5	0.15
Cr_2O_3	0.004
MnO	0.02
Total	100.39

[1] Analysis from Pye (1956, p.39).

dances of CaO, MgO, FeO, Fe_2O_3, and complete dominance of Na_2O over K_2O, indicative of a highly leucocratic albite trondhjemite. A significant quantity of CaO is probably incorporated in calcium carbonate and apatite as revealed by high CO_2 (0.33 percent) and moderate P_2O_5 (0.15 percent) contents. Abundances of CaO below 0.5 percent are relatively rare in normal igneous rocks as indicated by a rapid search of the literature (Breaks and Shaw 1973, p.110). Implications as to the significance of this abnormal major-element geochemistry cannot be posed until further detailed work is undertaken.

Obaskaka Lake Batholith

The Obaskaka Lake batholith[1] (120 km²) forms a conspicuous roughly circular pluton, approximately 12 km in diameter, between the Bamaji-Fry Lakes and Meen-Dempster Lakes metavolcanic-metasedimentary belts. The batholith is interpreted by the author as a syntectonic to late-tectonic, mesozonal diapiric pluton which has imposed a warp upon the metavolcanic structural trends. Quite possibly supracrustal rock units of the two aforementioned belts interconnect in an area of poor exposures located about 3 km west of Nabemakoseka Lake. No exposure was located in this area by the present survey.

Prevailingly, this batholith consists of massive, porphyritic (seriate) to equigranular, leucocratic to melanocratic, light to medium pink (fresh surface), biotite, hornblende-biotite, and biotite-hornblende (rare) quartz monzonite. Colour index varies between 8 and 30. Quartz is generally low in these rocks, varying from 10-20 percent. Towards the margins quartz content drops below 10 percent as these rocks grade into monzonite and syenodiorite. Decrease in quartz is generally concomitant with increasing colour index and dominance of hornblende over biotite within the more mafic border phases.

The porphyritic texture is often only subtly discernable, being most clearly revealed on stained, slab surfaces. This is in part a reflection of the common disguising presence of light pink plagioclase. Microcline phenocrysts which attain 20 mm in maximum length, usually display a gradation into matrix grain size. The matrix, as revealed by three thin sections, is hypidiomorphic-granular, and medium to coarse grained in texture. Plagioclase displays weak oscillatory zoning, which is often rendered conspicuous by preferentially altered zones arranged parallel to subhedral grain boundaries. Plagioclase generally is weakly altered to very fine-grained sericite. Quartz grains show evidence of disequilibrium recrystallization manifested by the development of a mosaic of irregularly shaped complexly interlocking grains within original single quartz grains. Myrmekitic plagioclase is occasionally present with wormy quartz rods and droplets clearly aligned discordantly to albite twinning. Homogeneous to perthitic microcline is a relatively late mineral phase, often incorporating significant volumes of euhedral to subhedral plagioclase grains and lesser quartz droplets. In rare instances, microcline appears to have replaced substantial portions of plagioclase grains. Minor accessories include sphene, zircon, epidote, and apatite. Euhedral sphene wedges commonly occur as inclusions within biotite. A typical visually estimated mode from the central more felsic phase revealed the following: plagioclase 40 percent, potassic feldspar 30 percent, quartz 20 percent, and biotite 8-10 percent.

[1]The Obaskaka, Kawashe, Graniteboss, and Duffell Lakes plutons were previously partially to completely delineated by Harding (1936) although no formal naming or general descriptions were advanced until the present survey.

Ochig Lake Batholith

The ovoid-shaped Ochig Lake batholith is the largest intrabelt granitic complex, occupying an area of approximately 230 km^2. This body is situated at the mutual coalescence of the Pickle Lake, Pickle-Dempster Lakes, and Pickle-Osnaburg Lakes metavolcanic-metasedimentary belts. Exposures are very limited and generally confined to the margins of the complex. Outwash glacial deposits and drumlin deposits are very widespread in the immediate area. Generally, the rock types are massive, medium- to coarse-grained, leucocratic, equigranular, recrystallized biotite trondhjemite to granodiorite. Rocks of quartz monzonite composition are notably rare. Contiguous to the supracrustal belts, the granitic rocks become perceptibly foliated and pervasively recrystallized. Two thin sections were prepared from outcrops located along Highway 599. Both sections displayed lobate granoblastic textures. Disequilibrium recrystallization textures are especially apparent in quartz-rich domains in which polycrystalline aggregates, characterized by scalloped to indented grain boundaries and considerable variation in grain size, are prevalent. In rare instances, an approach to a stable polygonal configuration within the quartz domains is evidenced by a uniformity in grain size and by smooth, relatively straight grain boundaries. Plagioclase, the most abundant mineral, has been pervasively altered to sericite and epidote. This alteration tends to be negligible in the extreme outer margin of the grains possibly reflecting a more sodic rich composition. Occasionally, plagioclase crystals show preservation of weak oscillatory zoning. Potassic feldspar, when present, is invariably fresh.

The Ochig Lake batholith can be reasonably well delineated aeromagnetically (Map 923G, ODM-GSC 1960) by virtue of a prominent negative anomaly (60 500 gammas total absolute field), characterized by very low magnetic relief (400 gammas). This expression contrasts strongly with several prominent bands of magnetite-bearing iron formation situated along certain sections of its perimeter.

Structural trends of the enclosing supracrustal rocks concordantly warp around the plutonic complex. A relatively narrow contact metamorphic aureole of epidote amphibolite rock has been superimposed upon the mafic metavolcanics. This small batholith appears to represent a mesozonal syntectonic complex.

Pickle Lake Stock

This small irregularly elliptical-shaped stock (50 km^2) is separated from the Ochig Lake batholith by a narrow screen of amphibolitized, foliated mafic metavolcanics. Known exposures are extremely sparse. Delineation of the stock was principally aided by compilation of information from Union Miniere Explorations and Mining Corporation Limited's private geological maps, previous government mapping (Thompson 1939) and aeromagnetic interpretation (Map 924G, ODM-GSC 1960). The only outcrop studied by the present survey consists of massive, deep pink (fresh surface), medium-grained, equigranular, highly leucocratic biotite granite. Abundances of major minerals, as megascopically estimated from a stained rock slab, are potassic feldspar 55 percent,

OGS 10 283

Photo 26–Thin section of granitic rock from Pickle Lake Stock. Sample collected from west side of stock and due east of Kapkichi Lake. Note fracturing of microcline and the infilling of the fractures with a more albitic(?) feldspar. Pickle Lake belt.

plagioclase 15 percent, quartz 30 percent, and biotite 1 percent.

In thin section, this rock is seen to have a lobate granoblastic texture, with most mineral components illustrating the effects of disequilibrium recrystallization. Microcline, the dominant mineral, usually exhibits cross-hatch twinning and perthitic intergrowths. Development of albite intergrowths appears attendant upon deformation, as a parallelism with microfracture directions in the host microcline is noticeable in several instances (Photo 26). Plagioclase shows slight to moderate sericitic alteration, with clear unaltered albitic rims usually unaffected. Quartz consists of recrystallized, irregularly shaped inequant crystals often displaying strong extinction banding. Grain boundaries usually are indented to serrated. A few of the larger quartz crystals display well developed subgrain networks.

Pye (1956, p.37) stated that diamond drilling has indicated granitic rocks to:

> ...underlie a portion of the Roeanor West group of Central Patricia Gold Mines and an area along the east shore of Pickle Lake. Inspection of core sample from the Roeanor West claims has shown that the granite is greyish pink in colour, medium-grained, and generally massive. Inspection of core samples indicating a similar variation in character as was found by Hurst (1930), and

Evans (1941, p.5). A typical massive variety was examined under the microscope and was found to consist largely of microcline, oligoclase, and quartz, with minor amounts of brown biotite and accessory magnetite and apatite. Also present and replacing the feldspars, particularly the plagioclase, are some sericite, epidote, and a little carbonate.

Stocks in the Riach Lake-Pashkokogan Lake Area

Several small granitic stocks intrude the metavolcanic-metasedimentary belt southeast of Soules Bay and a stock occurs 3 km west of Ace Lake. The presence of the latter stock is indicated by granitic outcrops on several small islands within Lake St. Joseph. This small intrusive body is probably no more than 10 km^2 in surface area. It is a massive, medium to fine-grained quartz monzonite which locally contains rounded, pebble-size amphibolite xenoliths. Pegmatite dikes composed of quartz, potassic feldspar and muscovite are seen cutting this body, and pegmatites with massive tourmaline-bearing zones occur within the metasediments east of the stock.

The small granitic stocks southeast of Soules Bay were not examined by members of this field party.

Webb Lake Stock

A small elliptical stock, approximately 50 km^2 in area, intrudes the Pashkokogan Lake-Misehkow River belt. The long axis of this pluton parallels the axis of an enclosing synclinal fold structure and the stock is readily apparent aeromagnetically (Map 932G, ODM-GSC 1960) as a pronounced magnetic negative anomaly (60 540 gammas absolute total field).

Within the center of the pluton, massive, medium-grained, light pink (weathered surface), equigranular leucocratic hornblende-biotite trondhjemite predominates. A thin section indicated a pervasively recrystallized, granoblastic (lobate) texture composed of the following visually estimated mineralogy: plagioclase 60 percent, quartz 15 percent, hornblende + biotite 15 percent, epidote 5 percent and potassic feldspar 5 percent. Blocky to crudely lath-shaped plagioclase exhibits intensely serrated grain boundaries indented by contiguous growth of recrystallized mineral phases. Alteration of plagioclase varies from very fine brown masses (argillic) to microscopically visible sericite. Quartz has been polygonized to irregular subgrains.

The marginal rock types tend to be well foliated, xenolithic, equigranular to porphyritic, grey (weathered surface) hornblende-biotite trondhjemite.

Zionz Lake Stock

Located in the eastern end of the Zionz Lake belt and largely covered by waters of Zionz Lake is a late granitic intrusion. This intrusion contains two distinct granitic phases and is referred to as the Zionz Lake stock.

The rock that comprises most of the stock is a medium grained, equigranular, massive, orange to pinkish rock of monzonitic composition. Granitic pegmatites cutting the metavolcanics and metasediments of the Zionz Lake belt are believed to be related to this stock.

In the northeast corner of the stock is a distinctively different phase of the intrusion. The granitic rock at this location is a foliated, porphyritic, seriate, biotite quartz monzonite. The phenocrysts range from 6 mm to greater than 25 mm in size and consist of potassic feldspar. Locally this phase is hornblende-rich and contains xenoliths of metamorphosed mafic volcanic rocks.

On weathered surface the potassic feldspar phenocrysts tend to weather in relief above a finer grained groundmass composed of varying proportions of plagioclase, quartz, hornblende, and biotite. Some potassic feldspar may also be present in the groundmass. Thin sections of the granitic phases were not examined.

ECONOMIC GEOLOGY (GRANITIC ROCKS)

Generally, the granitic rocks are relatively depleted in sulphophile minerals, exclusive of the Bamaji Lake batholithic complex. Only erratic sparse pyrite was observed in a few exposures of granitic rock by members of the survey party. Harding (1936, p.69) reported the occurrence of galena and pyrite contained within "a small quartz vein, less than one inch wide,...on the south shore of Mousetrap Lake," near the southeastern contact of the Graniteboss Lake stock. Also reported were flakes of molybdenite within pegmatitic dikes at the entrance of Carpenter Lake (Harding 1936). This mineral occurrence could not be located by the present survey.

(Late) Mafic Intrusive Rocks

Kibler Lake Stock

The small oblate-shaped Kibler Lake stock, situated 6.4 km northwest of Pickle Lake, lies close to the Pickle Lake metavolcanic belt. Although no known exposures exist, core specimens from a diamond drill hole of Union Miniere Explorations and Mining Corporation Limited (claim 297275, Patricia Mining Division) were donated to the writers. A conspicuous aeromagnetic expression, ranging up to a maximum of 62 500 gammas total absolute field (Map 924G, ODM-GSC 1960) is consequent upon abundant accessory magnetite, as observed in the drill core. Maximum dimensions of the stock were ascertained from the detailed aeromagnetic maps of UMEX (File 2442, Assessment Files Research Office, Ontario Geological Survey, Toronto) to be 6.8 km in length and 4.4 km in breadth.

The core specimens consist of homogeneous, massive, medium-grained melanocratic hornblende-biotite quartz bearing diorite. Small fine-grained mafic

xenoliths, and diminutive, white alaskite veins are present to a sparse degree. Fresh surface colouration is characterized by a clotted to 'salt and pepper' appearance.

A thin-section stained for plagioclase was visually estimated to contain the following minerals: plagioclase 40 percent, biotite 5 percent, hornblende 40 percent, quartz 8 percent, magnetite 5 percent, and sphene 2 percent. In thin section, fresh lobate granoblastic textures are obvious. Hornblende is usually poikilitic, containing innumerable quartz and magnetite inclusions and, very rarely, plagioclase. Unzoned anhedral plagioclase contains inclusions of all other major mineral phases. Needles of black rutile are often conspicuous and are invariably enclosed solely within the plagioclase. Magnetite is invariably rimmed and indented by irregular sphene grains. Additional accessory minerals present include apatite, epidote, garnet and pyrite.

A whole rock analysis of a representative portion of the core is given in Appendix A (Sample BC4-1). Most notable are the exceptionally high TiO_2, P_2O_5, and S.

Blackstone Lake Stock

This pluton was described briefly by Clifford (1969, p.35) and consists of a coarse-grained, hornblende-biotite-feldspar rock believed to be of ultramafic origin by Clifford (1969).

LATE PRECAMBRIAN

Pickle Crow Diabase Dike

The Pickle Crow diabase dike is a major regional feature which cuts across several structural blocks of the Superior Province and is best considered as a separate entity for the map-area. The dike has a prominent aeromagnetic expression (ODM-GSC 1970a,b, Maps P.575, P.577) and is traceable for a minimum distance of 560 km extending both south and north out of the map-area. To the north a right hand offset of the dike is known to exist on North Caribou Lake (Thurston *et al.* 1979). South of the map-area the aeromagnetic expression of the dike strikes southeast for a distance of approximately 100 km towards the center of Lake Nipigon where its trend becomes diffused and possibly masked by outliers of the Logan sills. Age relations with the latter are presently uncertain.

The aeromagnetic expression for the dike is strong in the English River and Uchi Lake Subprovinces. A weaker expression exists in the Gods Lake Subprovince and is lacking in the granitic terrain of the Cat Lake-Williams Lake batholithic complex lying between the Gods Lake and Uchi Lake Subprovinces. The lack of a magnetic expression in this batholithic complex does not negate its presence. The porphyritic granodiorites and quartz monzonites char-

acteristic of this complex contain local magnetite concentrations which create an erratic magnetic pattern for this area, and has most likely masked the presence of the dike.

Detailed aeromagnetic maps covering the strike length of the dike within the map-area indicate that the dike is a series of slightly overlapping *en echelon* dikes with right handed offset except in the Lowry Lake area where it is left handed (Maps 932G, 933G, 923G, 924G, ODM-GSC 1960). The lack of any significant deviation of the aeromagnetic trends on either side of the dike suggests that if the dike occupies a fault zone or *en echelon* fracture system, movement would have to be essentially vertical.

The Pickle Crow diabase dike cuts all the lithologies of the map-area, with possibly the exception of the granitic rocks of the Cat Lake-Williams Lake batholithic complex. The dike is thus considered to represent the latest geological event for the area other than Pleistocene events.

In the Pickle Crow area Pye (1956, p.47-49) described the Pickle Crow diabase dike as striking northwest and roughly paralleling the long axis of the Hooker-Burkoski stock. In this area Pye (1956, p.47-49) reported that the dike was 60 to 80 m in width and that it had been traced across the east part of the Dona Patricia property through a point 900 m east of the Central Patricia No. 1 shaft to the north boundary of Ponsford Township for a distance of about 8 km. In the vicinity of the Central Patricia mine diamond drilling has indicated that the dike dips 75 to 85 degrees northeast but considerable variation in dip and strike were observed throughout the area (Pye 1956, p.47-49). Pye (1956, p.47-49) considered the dike to be Late Precambrian (Keweenawan) in age.

North of the Crow River on the Waltricia claims, Pye (1956) reported the presence of two quartz diabase dikes, one 15 m thick and the other 23 to 30 m thick, which are similar to the Pickle Crow diabase dike.

Pye (1956) described the Pickle Crow diabase dike as brownish weathering, dark grey to black quartz diabase with small interlocking lath-like feldspar crystals. Within the center of the dike, feldspar grains are 5 to 10 mm in length, but along the contacts with the wall rocks, the rock becomes progressively finer grained and locally reaches a glassy state. In thin section the rock is seen to consist of plagioclase of andesine-labradorite composition with interstitial clinopyroxene and quartz along with accessory ilmenite, leucoxene, and apatite (Pye 1956, p.47-49). Pye reported that the dike has undergone slight hydrothermal alteration with some of the pyroxene being converted to a mixture of uralitic amphibole and chlorite.

In the Misehkow River-Pashkokogan Lake belt, the Pickle Crow diabase dike outcrops in several locations. The dike is exposed on the north shore of Coles Lake, on Atikokiwam Lake, and on the south channel of the Albany River. The dike varies from 60 to 90 m in width and cuts metasediments and metavolcanics at Coles Lake and South Channel of the Albany River. The dike has a fine grained aphanitic chilled margin containing fine-grained disseminated pyrite, and grades into a medium- to coarse-grained gabbro at the center. In a small narrow bay between Atikokiwam Lake and the South Channel, transverse faulting of the dike on the order of 0.3 to 3 m is present. This narrow bay may represent a minor fault zone.

The rock is grey-black to brownish-black on weathered surface and grey to black on fresh surface. Thin sections of the dike were not prepared.

CENOZOIC

Quaternary

PLEISTOCENE

Pleistocene features as such were not mapped by members of Operation Pickle Lake but major features were noted on air photos during routine helicopter mapping of bedrock geology.

To the east of the map-area in the Hudson Bay Lowlands, Craig (1968), McDonald (1968, 1971), Lee (1962), Skinner (1973), and Andrews (1968) have completed studies of glacial features. To the south and west of the map-area, Zoltai (1961; 1967) and Elson (1961; 1967) have studied Pleistocene features remaining from the Wisconsinan glaciation. Prest (1963) completed a reconnaissance study of Pleistocene deposits within the map-area and published maps covering the map-area (GSC Maps 4-1963, 5-1963). Zoltai (1960a,b) compiled two reconnaissance surficial geology maps which border the project area along the southern margin.

For this project, the above data were supplemented by air photo interpretation by G. Jordan; Figure 18 is a generalized sketch map of the Pleistocene features for the map-area.

Glacial History

East of the map-area in the Hudson Bay Lowlands, McDonald (1968, 1971) described nonglacial sediments consisting of marine sediments, peat and stream deposits which separate two distinctly different till-bearing stratigraphic sequences. The non-marine sediments are collectively referred to as the Missinaibi Formation. Carbon-14 dating of wood and peat samples from between the two tills gave dates beyond the limit of radio carbon dating techniques, however, a minimum age of more than 54,000 years B.P. is indicated (McDonald 1971, Table 1). Skinner (1973b, p.5, 23) has divided the Missinaibi Formation into four units: 1) marine, fossiliferous, bluish grey, compact sand and silt; 2) fluvial sand, gravel, and yellow to orange oxidized silt; 3) forest-peat deposits of mosses, sedges, sticks, logs, and stumps; and 4) lacustrine, well bedded, locally carbonaceous silt and clay. Little is known about the underlying tills, but they may have been deposited from ice flowing southwesterly perhaps from a dispersal center located over the Hudson Bay Lowlands (McDonald 1971, p.342; Skinner 1973b, p.9). Skinner (1973b, p.6) has divided the underlying sediments into three tills, separated by intertill glaciolacustrine deposits. Current directions in the glaciolacustrine deposits indicate a southwest direction of movement therefore suggesting that ice had not disappeared from the lowlands (Skinner 1973b, p.8). In the eastern part of the Moose River region the three tills may combine into one and it is therefore suggested that the multiple

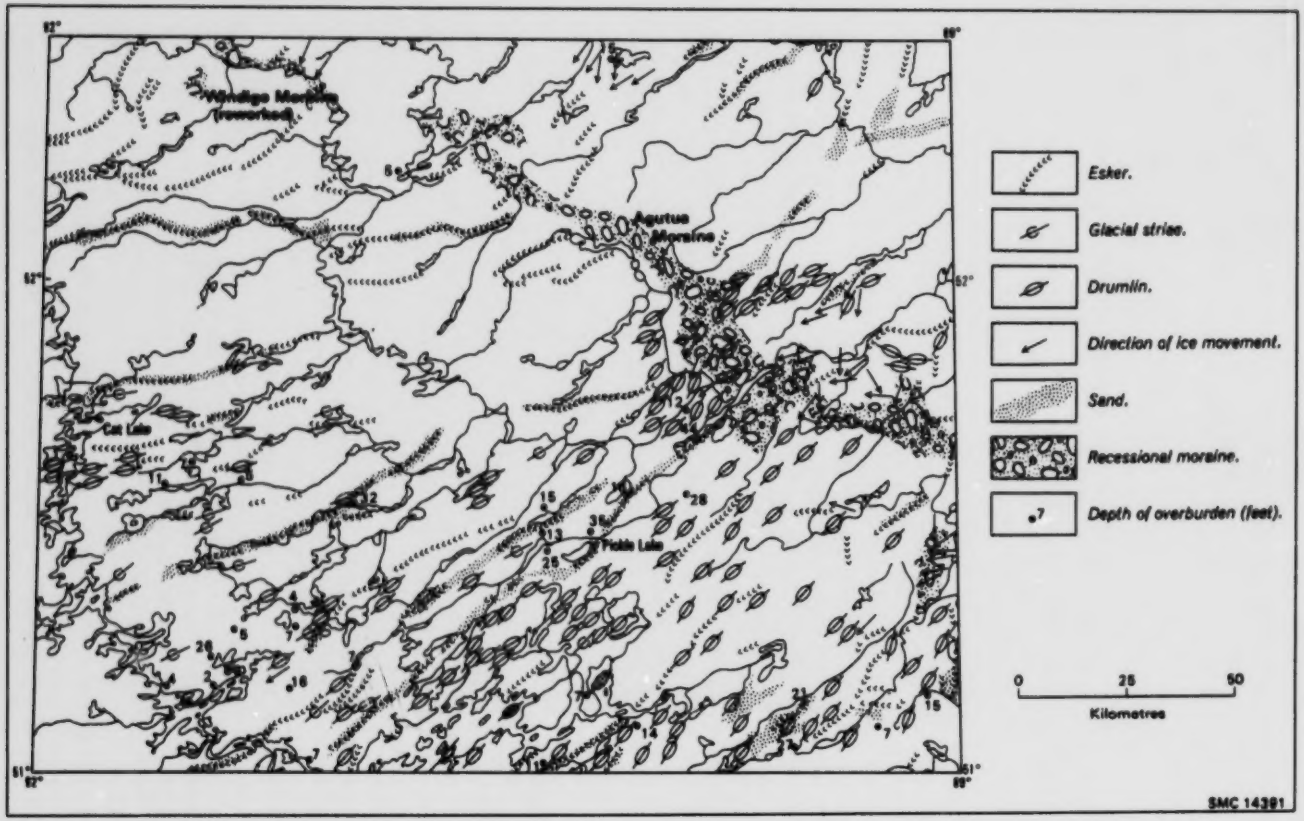

Figure 18–Generalized Pleistocene geology and depth of overburden in the Cat Lake—Pickle Lake area modified after Prest (1963).

till represents an oscillating ice front (Skinner 1973b, p.8). Skinner (1973b, p.13) considered these underlying tills to be Illinoian in age.

Skinner (1973b, p.23) considered that the Missinaibi Formation which overlies the above till-bearing sequence represents the following sequence of events: 1) incursion of the Bell Sea to an altitude 100 m above the present sea level; 2) recession of the Bell Sea to a level near present sea level; 3) a lake existing in front of an advancing ice sheet in which the sediments deposited within the lake were overridden by the advancing ice sheet. The pollen record within the Missinaibi Formation suggests that the local vegetation during this non-glacial period was similar to that which is now present in the region (McDonald 1968, p.89; Skinner 1973b, p.29). Skinner (1973b, p.30) considered the formation to represent an interglacial period rather than an interstadial.

Above the interglacial Missinaibi sediments two tills are recognized which are separated by proglacial lake sediments (McDonald 1968, p.96). These lake sediments are very similar to postglacial lake sediments that were deposited during the retreat of the latest Wisconsinan ice sheet (McDonald 1968, p.96). The proglacial lake sediments are absent in the central part of the Hudson Bay Lowlands suggesting that the ice may have occupied the central part of the lowlands continuously from Missinaibi time until the end of the last glaciation between 7500 and 8000 years B.P. (McDonald 1971, p.343; Skinner 1973b, p.12, p.40, 1973a, p.1).

Skinner (1973, p.31-36) named the two tills overlying the Missinaibi Formation the Adam and the Kipling. The tills were deposited by southwest moving ice sheets and the intertill non-glacial sediments have southwest indicated current directions (Skinner 1973b, p.32-33, p.54). Skinner (1973b, p.13) considered these tills as Wisconsinan age.

Overlying the Adam and Kipling tills and associated sediments in the southwestern and northwestern portions of the lowlands in the Moose River Basin are fresh water sand and silt deposits which underlie fossiliferous sediments of the Tyrrell Sea (McDonald 1968, p. 96; Skinner 1973b, p.37). These sediments probably represent a contribution of sediment and meltwater from the last retreating glaciers (Skinner 1973b, p.37). The northwestern sediments may represent the northwestern extension of Glacial Lake Agassiz and the southwestern sediments Glacial Lake Barlow-Ojibway (McDonald 1968, p.287). As deglaciation proceeded, water of the Tyrrell Sea inundated the entire lowland about 7800 years ago (Skinner 1973b, p.49). The fossil-bearing sand, silt, clay and gravel marine deposits of the Tyrrell Sea are in turn overlain by postglacial terrestrial deposits of peat, alluvium, and eolian sand (Skinner 1973b, p.37-38).

Prest (1970, p.732, 734) indicated that the Wisconsinan ice sheet began its halting retreat from western Ontario about 12 400±420 years ago and probably remained in the Hudson Bay area until about 7875±200 years ago. Andrews (1968, p.49) commenting on the rebound of the earth's crust after unloading by melting ice suggests two centers of uplift, one at Baker Lake in the Northwest Territories and another over east Hudson Bay. Skinner (1973b, p.49) established isobases on the highest marine water plane of the Tyrrell Sea which are convex southwest. From these data, Skinner (1973b, p.49) concluded that upward tilting had occurred on a gradient of approximately 30 cm/km with the center of uplift being established east or northeast of James Bay and in the

same area suggested by Andrews (1968). Andrews (1968, p.60) estimated that the approximate post-glacial uplift for east Hudson Bay as about 200 m and Craig (1968, p.75) indicates that uplift at Churchill is presently taking place on the order of 0.6 m per century.

Zoltai (1961, p.63) concluded, from his observations of glacial features within the region that borders the map-area to the south-southwest, that evidence indicates four discernible ice movements of the Wisconsinan glacier, with evidence for the last two being best preserved. Lake Agassiz I which formed after the retreat of the third of the four ice advances was subsequently drained due to waning of the ice sheet and its sedimentary deposits subjected to erosion. A re-advance of the glacial ice and then intermittant retreat initiated Lake Agassiz II (Zoltai 1961, p.80).

Retreat of the ice sheet from this fourth advance continued by stand-stills, and short term re-advances occurred generating the morainal features such as the Eagle-Finlayson, Hartmann, Lac Seul, and Trout-Basket moraines south of the map-area (Zoltai 1961, p.80). As the glacial ice continued to retreat northward the southern outlet eroded deeper causing Lake Agassiz to become shallower and thus contract in the south and expand in the north. As retreat and drainage continued outlets to the east were opened and the lake continued to fall to lower levels (Elson 1967, p.37).

Radiocarbon dates on Lake Agassiz material south and west of the map-area gave dates ranging from 9000 to 12 000 years ago (Elson 1967, p.89) and the lake therefore probably existed from about 8000 to 13000 years ago (Prest 1970, p.732-733). For a more complete chronological order of Lake Agassiz events the reader is referred to Elson (1967, p.91-94) and Prest (1970, p.732-733).

Prest (1963) completed a large scale reconnaissance investigation from 1959 to 1961 of a large area of northwestern Ontario of which the present map-area is a portion. Prest (1963, p.5) reported stratified sediments possibly correlative with the Missinaibi beds of the James Bay Lowlands approximately 3 degrees of longitude east of the map-area, but to date, no reports of Missinaibi-type sediments occurring within the map-area have been made.

The direction of ice movement was south to southwest within the map-area, but north of the map-area in the Big Trout Lake-Wunnummin Lake, Lansdowne House and Fort Hope areas (Hudec 1964, p.16; and Thurston *et al.* 1979), Prest (1963, p.5-6) reported evidence for an earlier northwest-trending ice movement. Prest (1963, p.6) attributed this to an Early Wisconsinan glaciation or possibly an early phase of Late Wisconsinan glaciation.

A brief summary of the deglaciation events in the map-area and surrounding area as described by Prest (1963) is as follows:

(1) The southwest corner of the map-area was probably the first area to be uncovered by the waning Late Wisconsinan ice sheet. As the ice retreated northeastward, waters of Lake Agassiz may have covered a portion of the southwest corner of the map-area. A later re-advance of the ice sheet halted at Trout Lake, just east of Red Lake and developed the Lac Seul moraine.

(2) From air photo interpretation, this Lac Seul moraine extends south and northeasterly from Trout Lake. Southeast of Windigo Lakes (northwest corner of map-area) the Lac Seul moraine has been de-

stroyed by a later advance of a northern ice-lobe which was responsible for the inter-lobate and end moraines south and southeast of Windigo Lake. Prest (1963, p.7) proposed to call this northern ice-lobe the "Windigo ice-lobe" and the resulting deposits as "Windigo Moraines".
(3) The glacier again retreated northward and Lake Agassiz reoccupied its position. The water levels of Lake Agassiz dropped as the retreating ice opened new drainage channels to the south and east. Most of the newly glaciated Lake St. Joseph area remained above the level of successively lower lake levels.
(4) A re-advance of the confluent northern and eastern ice sheets built a major northwest trending end moraine system, the northwestern end being formed from a reconstituted portion of the Windigo moraines. Prest (1963, p.8) proposed that the name "Agutua Moraine" be applied to this system. This moraine forms a prominent glacial feature crossing the map-area in a northwest direction.
(5) The ice then retreated rapidly into the Hudson Bay and James Bay Lowlands followed by increasingly lower lake levels. A minor re-advance of ice occurred before the final disappearance of the ice sheet. This re-advance did not reach the eastern edge of the map-area. After this re-advance the ice retreated eastward to James Bay draining the ice front glacial lakes. The retreat was then followed by an invasion of the marine waters of the Tyrrell Sea. From radiocarbon data the invasion of the marine waters is thought to have taken place approximately 7800 years ago (Prest 1963, p.10).

Glacial Deposits

Within the map-area are large areas of ground moraine. These areas are characterized by generally low relief and deposits of intermixed sand, gravel and boulders, locally covered with lacustrine clay, silt and sand. Areas covered by swamp, characteristic of ground moraine deposits, are widespread and bedrock outcrops vary from relatively scarce to abundant. Within the Lake St. Joseph area boulders of bedded, red, oolitic hematite have been left by the retreating ice sheets. These boulders are thought to have their source somewhere in the Paleozoic or Precambrian rocks northeast of the map-area. In hand sample the boulders of oolitic hematite appear similar if not identical to the oolitic Precambrian iron formations found in the Sutton Lake area in northeastern Ontario and described by Hawley (1926, p.21-25).

Transverse to the direction of ice movement one prominent morainal system is noticeable within the map-area. The Agutua end moraine traverses the map-area in a northwest-southeast direction from Windigo Lake to Snowflake Lake. The Agutua moraine can be traced on air photos northwest to the Sachigo and Stull Lakes area and southeast out of the map-area.

In the Windigo Lake area and just north of the map-area, interlobate moraines to the south and southwest of Windigo Lake mark the interaction of the Lac Seul ice-lobe and the Windigo ice lobe (Prest 1963, p.11). Satterly (1941, p.6) indicated extensive development of kettle features within this interlobate

morainal deposit. The moraine deposits have been reworked by glacial lake waters and are well beached in places (Prest 1963, p.11).

The Agutua moraine is topographically highest at a sharp bend in the Albany River at 85°05′ Longitude where it rises 150 m above the Albany River bed (Prest 1963, p.13); Prest also reported that the morainal deposits at upper Windigo Lake rise 75 m above the present lake levels. The well drained hills of the morainal deposits of the Agutua moraine show a larger population of deciduous trees in preference to the surrounding areas. During the fall, when the trees are turning colour, the relative distribution of the various tree species with respect to topography becomes readily apparent. The various topographical, glacial features stand out very prominently at this time.

Drumlins and drumlinoid ridges are widespread throughout the map-area, with most being drumlinoid ridges. These ridges are composed of intermixed sand, gravel, and boulders and only rarely exceed 30 m in height. Aspen, poplar and white birch display a preference to these ridges, possibly reflecting better surface drainage.

Within the map-area are numerous long sinuous esker complexes. These ridges are composed of unsorted to well sorted sand and gravel, locally well bedded. The ridges also locally display kames, kettle holes, and fluvial outwash deposits. The soils covering the esker complexes are well drained and aspen, poplar, and white birch prefer these ridges to the surrounding more swampy areas where conifers grow preferentially. The esker ridges stand out in relief relative to the surrounding areas and reach heights greater than 30 m relative to the surrounding terrain.

A particularly good example of glaciofluvial outwash, consisting of well sorted sand, is the level sand plain on which Hookers Air Service Limited have constructed an air strip at Menako Lake. Jackpine displays a preference for the sandy soils of the outwash desposits.

Within the map-area the most prominent lacustrine features occur in relation to the Agutua moraine. These lake deposits occur along the southwest margins of the moraine and consist of bedded sand and silt and locally beach sands and gravels.

Drift Thickness

As an aid to exploration, a compilation of drift thickness measurements derived from diamond drill logs obtained from the assessment files of the Ontario Geological Survey is included in Figure 18.

APPENDIX B

SUMMARY OF ASSESSMENT WORK AND OTHER INFORMATION FOR MINERAL DEPOSITS AND EXPLORATION IN THE CAT LAKE–PICKLE LAKE AREA

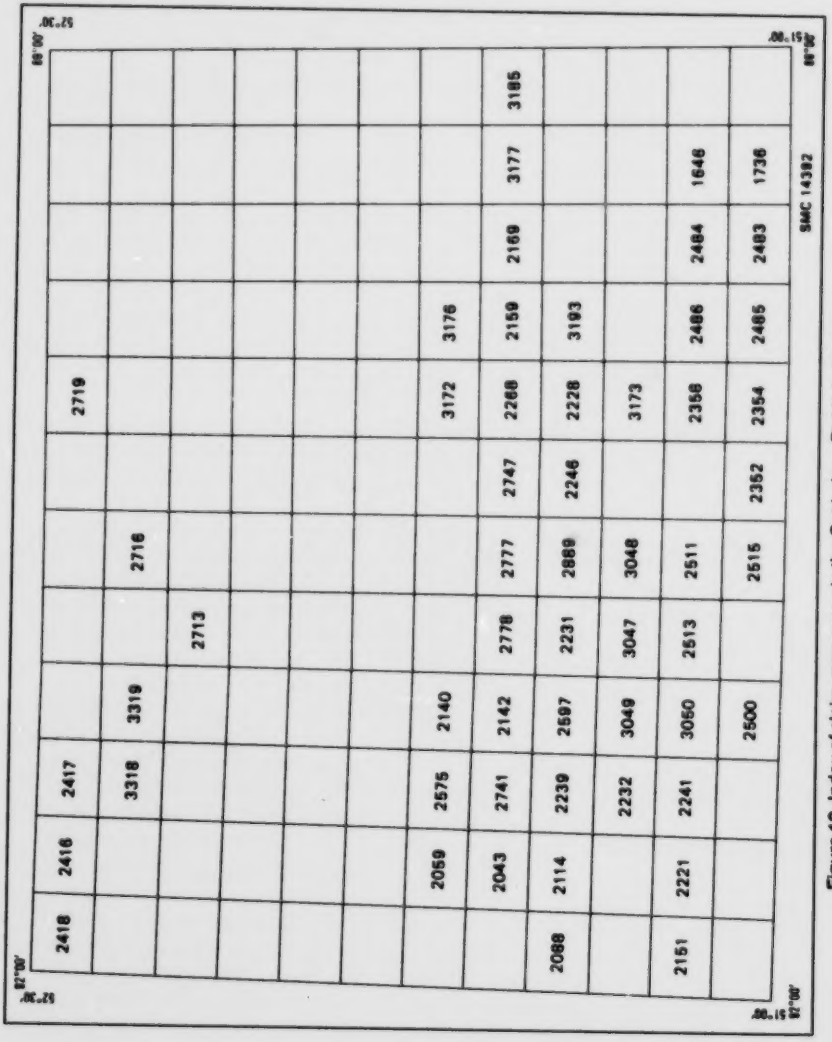

Figure 19–Index of claim-map areas in the Cat Lake—Pickle Lake area.

Figure 19 – Index of Claim Maps

CLAIM-MAP NUMBER	CLAIM-MAP NAME	CLAIM-MAP NUMBER	CLAIM-MAP NAME
1646	South of Beardmore	2486	Atikokiwam Lake
1736	Greenmantle Lake	2500	Johnston Bay
2043	Stoughton Lake	2511	Matapesatakum Lake
2059	Baggy Lake	2513	Duffell Lake
2088	Zionz Lake	2515	Carling Lake
2114	Zionz River	2575	Saddle Lake
2140	Cannon Creek	2597	Dobie Lake
2142	Cannon Lake	2713	Kecheokagon Lake
2151	Ferdinand Lake	2716	North of Wapamisk Creek
2159	Firstloon Lake	2719	Forester Lake
2169	Badesdawa River	2741	McVicar Lake
2221	Wesleyan Lake	2747	Ponsford Lake
2228	Dona Lake	2777	Nanos Lake
2231	Hergott Lake	2778	Wettlaufer Lake
2232	Nabemakoseka Lake	2889	South of Nanos Lake
2239	Meen Lake	3047	Wright Lake
2241	Fry Lake	3048	Caley Lake
2246	Kapkichi Lake	3049	Kawashe Lake
2268	Tarp Lake	3050	Drum Lake
2352	Riach Lake	3172	Atik Lake
2354	Caron Lake	3173	Coucheemoskog Lake
2358	Osnaburgh Lake	3176	Collishaw Lake
2416	Upper Windigo Lake	3177	Crerar River
2417	Nango Lake	3185	Snowflake Lake
2418	Shinbone Lake	3193	Weiberg Lake
2483	August Lake	3318	Vollett Lake
2484	Achapi Lake	3319	Stirland Lake
2485	Lowry Lake		

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATI-TUDE	LONG-ITUDE	TYPE OF WORK	DDH's	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
ACHAPI LAKE	Monpre Mining Co. Ltd.	•	51°07'54"	89°44'45"	AEM,EM,DN,GL		?	AFRO 63.1108		py,mag,IF
	Hudson Bay Explor. & Dev. Co. Ltd.	•	51°08'00"	89°34'00"		1–518'	1971	private drill records		py
	Sturdy Mines Ltd.		51°07'54"	89°44'45"				AFRO 63.2614		mag IF
		•	51°07'54"	89°44'45"	EM,MAG	3	1968	AFRO 63.2614; Shklanka 1969, p.174-175	Cu 0.14-0.48% Ni 0.15-0.17%	po,cp
		•	51°08'51"	89°32'30"	ARA,EM,MAG	6–5354'	1968	AFRO 2.843; AFRO R.10; NM July 18, 1968 p.1,2; NM Aug. 1, 1968; NM, Aug. 22, 1968	Fe,P_2O_5, TiO_2 S, SiO_2, Al_2O_3	mag-hem IF, py,po,gf
ATIKOKIWAM LAKE	Monpre Mining Co. Ltd. (Humming Bird Lake)	•	51°07'00"	89°45'00"	AMG,EM,DN,GL		1970	Monpre Mining Co. Ltd. prospectus	Au trace Ag trace Cu trace	py
AUGUST LAKE	The Algoma Steel Corp. Ltd.	•	51°03'27"	89°33'18"	MAG	4–1796'	1968-1969	MNR Files, Kenora, Shklanka 1968, p.453; AFRO 63.2281		mag IF
	Hudson Bay Expl. & Dev. Co. Ltd.	•	51°06'50"	89°35'20"		2–468'	1970	private drill records		py,gf
		•	51°04'00"	89°36'10"		1–535'	1970	private drill records		py,gf
BADESDAWA RIVER	Union Miniere Expl. & Mining Corp. Ltd.	•	51°34'12"	89°44'12"		1	1971	D. Goffaux, UMEX, pers. comm.		po,py
			51°33'40"	89°43'30"		1–103'	1972	private drill logs		
			51°32'50"	89°45'00"		1–113'	1972	private drill logs		
BAGGY LAKE	Roy Reaman	•	51°38'00"	91°33'40"		1–379'	1969	AFRO R.10		py
	Mextor Minerals	•	51°37'50"	91°34'40"	EM,MAG	1–454'	1970	AFRO R.11, SMDR 00493		py,po,cp,gf
		•	51°37,50"	91°35'10"		1–393'	1970	AFRO R.11, SMDR 00493		py,po,cp,gf
		•	51°38'20"	91°35'30"		1–341'	1970	AFRO R.13, SMDR 00493		po,py,cp
		•	51°38'60"	91°35'50"		1–313'	1970	AFRO R.12, SMDR 00493		po,cp,py
BEAVIS LAKE	The Algoma Steel Corp. Ltd.	•	51°09'00"	89°05'24"	MAG	8–2722'	1967	MNR Files, Kenora; Shklanka 1968, p.452		mag-hem, py,po,cp
CALEY LAKE	Union Miniere Expl. & Mining Corp. Ltd.	•	51°19'20"	90°35'00"		1–203'	1972	private drill logs		py,po
		•	51°17'10"	90°43'20"		1–200'	1972	private drill logs		py,po
		•	51°17'30"	90°41'30"		2–722'	1972	private drill logs		po,py

CALEY LAKE	Hasaga Mines Ltd. (Koval Ohman Option) and Little Long Lac Mines Ltd.	•	51°15'12"	90°33'00"		87–2085'	1953-1954	MNR Files, Kenora, Ferguson et al, 1971, p. 245	149,000 tons averaging 0.19 oz Au/ton 41,000 tons averaging 0.14 oz Au/ton	asp,py,po,gf
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°17'35"	90°43'45"		1–171'	1973	AFRO R.10		po,cp,py
		•	51°17'45"	90°43'15"		1–206'	1973	AFRO R.10		po,py
		•	51°18'00"	90°43'45"		1–206'	1973	AFRO R.10		py
		•	51°15'40"	90°30'40"		1–371'	1973	AFRO R.11		py,po,cp
		•	51°19'45"	90°30'10"		1–294'	1973	AFRO R.12		py,cp
CANNON LAKE	C.L. Boland (Card Lake Copper Mines Ltd., Bochawna Copper Mines Ltd.)	•	51°33'25"	91°00'50"	EM,MAG	4–1103'	1969	AFRO R.10	Cu 0.01-1.10% Ni nil-0.27% Au nil-0.005 oz/ton Ag nil-0.010 oz/ton	po,py, cp,mo, sp
	Ben Ohman	•	51°35'20"	91°11'15"			1970	Fenwick 1972		asp,py
		•	51°33'30"	91°06'00"			1972	Fenwick 1972		py,IF
		•	51°35'40"	91°14'10"			1972	Fenwick 1972		po
	Card Lake Copper Mines Ltd., Bochawna Copper Mines Ltd.	•	51°37'56"	91°33'54"	GL	4	1969	SMDR 601, Card Lake		Cu,Zn
	Card Lake Copper Mines Ltd.	•	51°37'20"	91°19'00"	EM,MAG	3	1969	Report on Card Lake property, mineral Resources Branch, EMR		IF
	Union Minere Expl. & Mining Co. Ltd.	•	51°35'05"	91°12'35"		1–204'	1973	AFRO R.11		py,po
		•	51°35'10"	91°12'55"		1–200'	1973	AFRO R.11		po,py
		•	51°34'50"	91°14'40"		1–200'	1973	AFRO R.11		po,py
		•	51°35'20"	91°12'15"		1–266'	1973	AFRO R.11	Cu 0.1-1.0%	py,po,cp
		•	51°34'50"	91°13'40"		1–202'	1973	AFRO R.11		po
		•	51°33'35"	91°06'00"		1–266'	1973	AFRO R.12		po
		•	51°33'30"	91°05'00"		1–250'	1973	AFRO R.12		gf,po,py
		•	51°33'20"	91°04'55"		1–200'	1973	AFRO R.12		po,py
		•	51°33'25"	91°04'00"		1–400'	1973	AFRO R.12		po,py,gf
		•	51°35'20"	91°12'20"		1–243'	1973	AFRO R.11		po,cp
CARON LAKE	Canadian Nickel Co. Ltd.	•	51°06'50"	90°03'20"		1–168'	1971	AFRO R.12		po,py
		•	51°06'42"	90°01'45"		1–165'	1971	AFRO R.13		po,py,cp
		•	51°05'57"	90°01'35"		1–172'	1971	AFRO R.14		po,py,gf
		•	51°03'03"	90°06'20"		1–202'	1971	AFRO R.15		po,py,gf
	Falconbridge Nickel Mines Ltd.	•	51°02'20"	90°12'45"	EM,MAG	2–533'	1972	AFRO R.15, 2.621		po,py,gf
	Selco Mining Corp. Ltd.	•	51°00'40"	90°14'50"		1–357'	1971	AFRO R.10		po,py
		•	50°01'00"	90°13'55"		1–351'	1971	AFRO R.11		po,py,gf

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
COLLISHAW LAKE	Canadian Nickel Co. Ltd.	•	51°38'00"	89°59'00"		1–197'	1971	AFRO R.11		po,py,cp
		•	51°34'18"	89°54'00"		2–390'	1971	AFRO R.12		po,py,cp,gf
		•	51°43'12"	89°54'18"		1–130'	1971	AFRO R.12		po,py
	Conwest Explor. Co.	•	51°37'48"	89°56'30"		1–354'	1971	AFRO R.13		po,py,cp
			51°38'10"	89°55'00"	AEM,AMG,EM,MAG			AFRO 2.625		
	Crowshore Patricia Gold Mines Ltd., Conwest Explor. Co.	•	51°39'54"	89°52'00"	GL		1948	MNR files, Red Lake	Au 0.03 oz/ton	cp,po,py
		•	51°39'06"	89°55'06"		12–1900'	1948	MNR files, Red Lake Rept. 10	Au	py,po,cp,gn
		•	51°38'00"	89°55'06"	GL	36–8187'	1948	MNR files, Red Lake	Au	po,cp,py,asp
	Union Minere Explor. & Mining Corp. Ltd.	•	51°42'00"	89°56'06"	AEM,AMG	1	1971	D. Goffaux, UMEX		po,py,gf
		•	51°40'20"	89°56'20"	AEM,AMG	2–310'	1971	AFRO R.17, 2.544		py,po
		•	51°37'40"	89°59'25"	AEM,AMG	1–299'	1972	AFRO R.14, 2.544		py,po
		•	51°37'52"	89°53'35"		1–520'	1972	AFRO R.15		po,cp
		•	51°38'00"	89°53'10"		2–766'	1972	AFRO R.15		py,po
			51°38'15"	89°52'35"		2–404'	1972	AFRO R.15		
		•	51°39'10"	89°51'35"		1–290'	1972	AFRO R.16		py,po
		•	51°41'10"	89°56'30"	AEM,AMG	1–250'	1973	AFRO R.18, 2.544		py,po,cp
		•	51°41'12"	89°56'20"	AEM,AMG	1–199'	1973	AFRO R.18, 2.544		po,py,cp
		•	51°37'50"	89°59'25"	AEM,AMG	1–217'	1973	AFRO R.14, 2.544		po,py,cp
		•	51°42'20"	89°57'40"		1–211'	1972	private drill logs		py,po
CONNELL TP.	Mitchell Group	•	51°31'51"	90°06'00"			1948	MNR Files, Red Lake	Au 0.02-0.17 oz/ton	qv,py
	Cohen-MacArthur Claim Group	•	51°31'15"	90°03'18"		3	1933	Thompson (1938, p.49)	Au 0.26 oz/ton across 7'	asp
		•	51°31'06"	90°03'45"		10	1933	Thompson (1938, p.49)	Au	asp
	Albany River Mines Ltd., Pickle Crow Gold Mines Ltd. (Albany Shaft)	•	51°31'10"	90°01'30"			1928	Hurst (1930, p.15-17) Thompson (1938, p.31-35) Pye (1956, p.216-226) Ferguson et al. (1971, p.202)	Au,Ag	py,cp,asp gn,Au,sp
	Pickle Crow Gold Mines Ltd.					3581–430349'	1935-1966	Hurst (1930, p.28-32) Thompson (1938, p.53-63) Pye (1956, p.166-232)	Au	po,py,Au shee
	(No. 3 shaft)	•	51°31'10"	90°02'15"				Ferguson et al. (1971, p.202-203) Ferguson (1966, p.69-86)	Au,Ag	Au,shee po,py,cp,gn
	(No. 2 shaft)	•	51°31'55"	90°02'45"						
	(No. 1 shaft No. 4 shaft)	•	51°31'30"	90°03'00"					Au,Ag	po,py,asp,sp cp,gn,shee, Au,Ag
	(No. 5 vein)	•	51°29'50"	90°03'10"					Au	po,py,cp,asp

COUCHEEMO-SKOG LAKE	Canadian Nickel Co. Ltd.	•	51°17'55"	90°13'20"		1–188'	1971	AFRO R.11		po,py
	Monpre Iron Mines Ltd.	•	51°20'24"	90°04'30"	AEM,MAG,DN	2–51'	1960	AFRO 63.1098	Au	py
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°17'35"	90°12'05"		2–243'	1972	AFRO R.12		po,py
		•	51°18'00"	90°13'10"		1–146'	1971	AFRO R.13		
		•	51°20'00"	90°13'00"		2–300'	1972	private drill logs		py,gf
		•	51°19'40"	90°10'40"		1–150'	1972	private drill logs		py,po
			51°18'40"	90°12'30"		1–153'	1972	private drill logs		
		•	51°17'50"	90°12'40"		1–125'	1972	private drill logs		py,po,gf
		•	51°22'30"	90°04'30"		2–300'	1972	private drill logs		gf,py
CRERAR RIVER	Canadian Nickel Co. Ltd.	•	51°33'25"	89°20'50"		1–360'	1971	AFRO R.10		po,py,mag
DOBIE LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°23'00"	91°13'40"		1–271'	1972	private drill logs		py,po,mag
		•	51°23'00"	91°13'20"		1–275'	1972	private drill logs		po
DONA LAKE	Central Patricia Gold Mines Ltd. (Wright Group)	•	51°26'36"	90°09'24"	GL		1945	MNR files, Red Lake; Pye (1956 p.142-143)	Au tr-0.03 oz/ton	py
	Conwest Explor. Co.	•	51°29'40"	90°12'10"		1–400'	1971	AFRO R.12		po,py
			51°29'30"	90°13'30"	AEM,AMG,EM,MAG		1971	AFRO 2.625		
	James Bay Mining Corp.		51°28'00"	90°08'30"	EM		1972	AFRO 2.742		
			51°26'30"	90°09'00"	EM		1972	AFRO 2.771		
	Transterre Explor. Ltd.		51°23'30"	90°02'00"	EM,MAG		1972	AFRO 2.1001		
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°27'15"	90°00'30"		1–122'	1971	AFRO R.11		po,py
			51°23'40"	90°05'00"	EM,MAG		1971	AFRO 2.544		
		•	51°23'35"	90°05'55"		1–300	1972	AFRO R.13		po
		•	51°22'45"	90°07'05"		1–196'	1973	AFRO R.14		po,py,mag
DORAN LAKE	Hanna Mining Co.	•	50°57'40"	90°30'15"	AMG	2–402'	1973	AFRO R.13	Au 0.005 oz/ton	mag,po,py
		•	50°57'25"	90°31'15"	AMG	1–252'	1973	AFRO R.13	Cu 0.01%, Au nil	po,py,gf
DRUM LAKE	Cochenour Willans Gold Mines Ltd.	•	51°11'20"	91°01'30"		2–256'	1970	AFRO R.17		po,py,cp
		•	51°10'10"	91°01'10"		1–101'	1970	AFRO R.18		po,py,cp
		•	51°11'00"	91°06'30"		3–428'	1970	AFRO R.19		po,py,cp
		•	51°14'40"	91°07'10"		1–101'	1970	AFRO R.20		po,py
		•	51°08'40"	91°03'00"		1–101'	1970	AFRO R.21		po,py,cp
		•	51°09'30"	91°03'00"		1–160'	1970	AFRO R.22		po,py
		•	51°14'20"	91°13'30"		1–207'	1971	AFRO R.23		py
		•	51°14'50"	91°03'30"		2–223'	1970	AFRO R.24		py,po,sp,cp
		•	51°14'40"	91°04'20"		1–135'	1970	AFRO R.25		py,po
		•	51°14'40"	91°04'20"		1–175'	1971	AFRO R.25		py,po,cp
		•	51°15'00"	91°05'20"		2–235'	1970	AFRO R.26		po,py,sp,cp,gn
		•	51°12'50"	91°07'00"		3–434'	1971	AFRO R.27		py,po,sp

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
DRUM LAKE	Cochenour Willans Gold Mines Ltd.	•	51°14'40"	91°08'20"		1–135'	1971	AFRO R.28		py,po
		•	51°14'20"	91°01'35"	EM	1–131'	1972	AFRO R.30, 2.1083		po,py
		•	51°14'18"	91°01'30"	EM	1–150'	1972	AFRO R.30, 2.1083		po,py,sp,IF,cp
			51°15'00"	91°13'30"	EM,MAG			AFRO 2.1083		
			51°14'40"	91°04'30"	EM,MAG			AFRO 2.804		
			51°14'40"	91°07'30"	EM			AFRO 2.650		
			51°09'30"	91°04'45"	EM			AFRO 2.410		
			51°11'25"	91°01'30"	EM			AFRO 2.778		
			51°10'20"	91°01'20"	EM			AFRO 2.778		
			51°09'05"	91°02'55"	EM			AFRO 2.778		
			51°11'10"	91°06'30"	EM			AFRO 2.778		
	C.C. Huston Partnership	•	51°12'20"	91°08'00"		2–120'	1970	AFRO R.10	Cu tr-0.26% Ni nil-tr Zn nil-0.26% Au, Ag nil-tr	py,po gf,cp
		•	51°12'00"	91°07'00"		3–283'	1970	AFRO R.11	Cu tr-0.05% Ni nil-0.01% Zn nil-0.04% Au,Ag nil-tr	po,py,gf,cp
		•	51°11'10"	91°02'40"		5–552'	1970	AFRO R.12		po,py,gf
		•	51°11'30"	91°03'50"		1–108'	1970	AFRO R.13		po,py,cp
	Selco Explor. Co.	•	51°11'20"	91°07'30"		5–1106'	1970	AFRO R.14	Ag nil-0.08 oz/ton Au nil-tr	po,py,cp,sp,Ag
		•	51°11'40"	91°10'30"		1–125'	1970	AFRO R.15		py,po,cp,sp
		•	51°10'00"	91°06'40"		2–248'	1970	AFRO R.16		py,cp
	Union Miniere Explor. & Mining Corp. Ltd.		51°08'30"	90°06'25"	EM			AFRO 2.087		
			51°08'30"	91°06'00"		2–270'	1972	private drill logs		
DUFFELL LAKE	Cochenour Willans Gold Mines Ltd.	•	51°12'40"	90°58'00"		1–84'	1970	AFRO R.10	Au trace, Ag nil Ni nil	po,py
		•	51°13'20"	91°00'00"		2–135'	1970	AFRO R.11		mag,IF,po,py
	Newconex Canadian Explor. Ltd.	•	51°14'50"	89°57'50"			1969	AFRO 63.2807		py
		•	51°12'20"	89°49'10"			1969	AFRO 63.2807		py,gf
		•	51°12'25"	89°48'50"			1969	AFRO 63.2807		py,gf
	Ontario Dept. Mines		51°13'40"	89°58'10"			1935	Harding (1935, p.53-73)	Au 0.02 oz/ton	
FERDINAND LAKE	Madsen Red Lake Gold Mines Ltd.	•	51°12'30"	91°53'30"		2–219'	1969	AFRO R.10	MoS_2 nil-0.96%	mo,py,po,cp
		•	51°12'30"	91°54'30"		2–155'	1969	AFRO R.11	MoS_2 nil-0.08%	mo
	Ontario Division Mines	•	51°12'20"	91°15'30"			1972	Sage et al. (1973c)		mo,py
		•	51°11'20"	91°14'40"			1972	Sage et al. (1973c)		py
		•	51°12'20"	91°15'25"			1972	Sage et al. (1973c)		mo

FIRSTLOON LAKE	Canadian Nickel Co.Ltd.	•	51°37'10"	89°53'50"	AEM,AMG	2–332'	1971	AFRO R.10, 2.544		po,py,cp,mt
	Coniagas Mines Ltd.				DN		1936	Thompson (1938), Shklanka (1968, p.227)		mag,IF
	Conwest Explor. Co.	•	51°35'30"	89°50'36"	AEM,AMG	1–551'	1972	AFRO R.13, 2.676	Zn (.04%)	po,py,gf,IF
		•	51°35'05"	89°47'50"	AEM,AMG	1–399'	1972	AFRO R.14, 2.676		po,py,sp,gf,cp
		•	51°34'12"	89°44'12"	AEM,AMG	1–374'	1972			po,py,cp,mag,IF
		•	51°34'25"	89°45'00"	AEM,AMG	1–482'	1973	AFRO R.15		po,py,mag
	Union Miniere Explor. & Mining Corp. Ltd		51°34'35"	89°45'20"	AEM,AMG		1971	AFRO 2.544		
			51°32'55"	89°45'20"	AEM,AMG		1971	AFRO 2.544		
			51°30'30"	89°58'00"	EM,MAG			AFRO 2.605		
		•	51°34'35"	89°51'10"	AEM,AMG	1–536'	1972	AFRO 2.544, R.16		gf,po
		•	51°34'20"	89°51'00"	AEM,AMG	1–421'	1972	AFRO R.16, 2.544		gf,mag
		•	51°34'40"	89°57'40"	AEM,AMG	1–350'	1972	AFRO R.17, 2.544		po,py
		•	51°34'45"	89°56'00"		1–495'	1972	AFRO R.18, 2.544		IF,mag
		•	51°36'05"	89°55'25"	AEM,AMG	1–358'	1972	AFRO R.19, 2.544		po,py
		•	51°37'10"	89°53'50"	AEM,AMG	1–200'	1973	AFRO R.10, 2.544		po,py,cp,mag
		•	51°37'25"	89°56'40"	AEM,AMG	1–246'	1973	AFRO R.20, 2.544	Cu 0.02%	po,cp
			51°36'30"	89°59'55"	AEM,AMG	1–337'	1973	AFRO R.21, 2.544		
		•	51°35'25"	89°57'45"	AEM,AMG	1–218'	1973	AFRO R.22, 2.544		mag,po,py,cp,gf
			51°32'20"	89°57'50"		1–445'	1972	private drill logs		
		•	51°32'00"	89°59'20"		1–348'	1972	private drill logs		py,po,gf
		•	51°32'00"	89°58'50"		1–490'	1972	private drill logs		gf
FORESTER LAKE	Hooker-Wilson Group	•	52°28'12"	89°56'06"	GL		1941	MNR files, Red Lake		Au,asp,py,cp,gn
	Rio Tinto Canadian Explor. Co. Ltd.	•	52°27'12"	89°56'06"			1961	AFRO 63.1246	Au 0.005-0.03 oz/ton Ag 0.05-0.14 oz/ton	Au,as
	International Nickel Co. Ltd.	•	52°27'36"	90°05'06"		1–409'	1962	D.D. Report 9-1-66		po,py,as
	Jardine Syndicate	•	52°23'00"	89°52'18"			1941	MNR files, Red Lake	Au 0.54 oz/ton	Au,asp
	Ontario Division Mines	•	52°23'30"	89°51'00"			1972	Sage et al. (1973b)		asp,cp,po
		•	52°2736"	89°51'21"				Sage et al. (1973b)		po,py
		•	52°27'21"	89°52'30"				Sage et al. (1973b)		po,cp
	Rio Tinto Canadian Explor. Co. Ltd.	•	52°28'09"	90°07'21"	EM,DN,GL	2–144'	1963	AFRO 63.1246, private company files	Au nil-0.02 oz/ton	po,gf,Au
		•	52°27'36"	90°06'45"	EM,DN,GL		1963	AFRO 63.1246	Ag 0.12 oz/ton	
		•	52°27'54"	90°06'30"	EM,DN,GL		1963	AFRO 63.1246	Ni 0.18%	
		•	52°27'45"	90°07'15"	EM,DN,GL		1963	AFRO 63.1246	Cu 0.14%	cp,mo,py,po
FRY LAKE	Flicks Red Lake Gold Mines Ltd.	•	51°14'20"	91°22'15"			1946	MNR files, Red Lake	Au 0.25 oz/ton	py
	McCombe Mining & Explor. Ltd.	•	51°10'25"	91°25'20"		11–565'	1954	AFRO R.10, Lang et al. (1962, p.248) Robertson (1968, p.62)	U_3O_8 0.24%	py, uranothorite?

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
FRY LAKE	Kirkland Townsite Gold Mines Ltd.		51°10'25"	91°25'20"	AMA,GL		1968	AFRO 63.2510		
			51°10'20"	91°26'30"	AMA,GL		1968	AFRO 63.2510		
	R. Knappet	•	51°10'25"	91°25'20"			1970	MNR files, Red Lake	Au 0.52 oz/ton	Au,U,py
			51°10'20"	91°26'30"			1970	MNR files, Red Lake; prop. examination report by H.L. King, MNR files, Kenora	Au 0.01-0.40 oz/ton Ag tr-0.16 oz/ton U_3O_8 0.002-0.10% ThO_2 0.05-0.07%	
		•	51°09'40"	91°27'50"			1970	prop. examination report by H.L. King, MNR files, Kenora	Cu 0.01-0.39% Ag tr-0.38 oz/ton	py,cp
	Domes Mines Ltd., Campbell Red Lake Gold Mines Ltd., Sigmas Mines Ltd.	•	51°10'25"	91°26'40"			1965-1966	Mineral Resources Branch files MNR	Au, Ag	Au,Ag
	R. Knappet		51°10'10"	91°26'40"			1970	Radioactive occurrence discovered by R. Knappet and H.L. King	RA	
			51°09'50"	91°27'00"			1970		RA	
			51°10'30"	91°28'50"			1970		RA	
	Cochenour Willans Gold Mines Ltd.		51°12'30"	91°21'25"			1970?	private geological map	Au 0.28 oz/ton Ag 0.80 oz/ton	
		•	51°10'20"	91°26'50"			1970	private geological map		mo,py
	Loon prospect	•	51°09'00"	91°29'00"		12-2576'	1966	MNR files, Red Lake; Johnson (1968, p.43)	Mo 0.05-3.28% Cu nil-2.91% Au tr-0.47 oz/ton Ag tr-34.41 oz/ton Bi tr-0.48% Pb tr-0.15% Zn tr-0.10%	mo,py,cp,bm?
		•	51°08'50"	91°29'33"		1-205'	1966	private drill records		mo
		•	51°08'50"	91°29'37"		1-156'	1966	private drill records	Cu 0.23% Mo 0.53%	mo,cp,sp
		•	51°08'50"	91°29'15"		1-149'	1966	private drill records	Cu 0.03% Mo 0.09%	mo,cp,sp
		•	51°12'20"	91°21'30"		1-132'	1970	AFRO R.13		po,sp,py,cp
		•	51°08'20"	91°28'40"		1-198'	1970	AFRO R.14		py,po
		•	51°11'20"	91°22'20"		1-160'	1970	AFRO R.16		po,py
		•	51°10'10"	91°24'00"		1-157'	1970	AFRO R.15		po,py
		•	51°12'00"	91°22'00"		1-101'	1970	AFRO R.13		po,py,cp
		•	51°15'00"	91°21'00"		2-208'	1970	AFRO R.17		po,py,cp
		•	51°14'40"	91°22'00"		3-234'	1970	AFRO R.18		py,po,IF
		•	51°14'20"	91°23'00"		1-252'	1971	AFRO R.19		py,mag,IF

FRY LAKE	Loon Prospect	•	51°15'00"	91°23'40"		1–202'	1972	AFRO R.20		py,gf,po
		•	51°14'50"	91°23'50"		1–126'	1972	AFRO R.20		py,gf
		•	51°14'55"	91°15'25"	EM					
	Selco Explor. Co. Ltd.	•	51°11'30"	91°20'00"		1–199'	1970	AFRO R.12		py,po
		•	51°13'00"	91°16'20"	EM,MAG,GL	4–1089'	1970	AFRO R.11		po,py,sp,cp
GREENMANTLE LAKE	The Algoma Steel Corp. Ltd.	•	51°06'09"	89°16'45"	MAG,GL	26–14052'	1966-1967	MNR files, Red Lake		mag,hem
	Standard Iron Mines Ltd.		51°06'09"	89°16'45"		7–949'	1962			
GREMM LAKE	The Algoma Steel Corp. Ltd.	•	51°03'30"	89°13'54"	MAG		1967	private comm.		mag,IF
HAMMERTON LAKE	Ontario Division Mines	•	51°14'20"	91°32'55"			1972	Sage et al. (1973c)		mag,py
JOHNSTON BAY	Cochenour Willens Gold Mines Ltd.		51°06'55"	91°11'00"	MAG			AFRO 2.411		
	Cominco Ltd.	•	51°00'30"	91°06'45"		1–257'	1970	AFRO D.D.12		gf,py,po,cp
		•	51°01'00"	91°06'18"		1–340'	1970	AFRO D.D.13		po,py,gf
	Cochenour Explor. Ltd.	•	51°02'30"	91°07'36"		1–106'	1970	AFRO D.D.14		py,po
		•	51°06'24"	91°10'54"		1–125'	1970	AFRO D.D.11		py,po,cp
		•	51°01'54"	91°06'18"		1–101'	1970	AFRO D.D.15		py,po
		•	51°01'54"	91°05'48"		1–101'	1970	AFRO D.D.10		py,po,cp
KAPKICHI LAKE	Central Patricia Gold Mines Ltd., Conwest Explor. Co.				MAG	15	1946-1950	AFRO R.15, 63.178		
	James Bay Mining Corp.		51°24'00"	90°26'00"	EM			AFRO 2.737		
	Kapkichi Nickel Mines Ltd.				EM,MAG		1956-1960			
					EM,MAG	4–2400'	1958	AFRO 63.957, R.13	Cu, Ni	
	Transterre Explor. Ltd.		51°23'20"	90°28'00"	EM,MAG			AFRO 2.1000		
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°28'15"	90°21'45"	AEM,AMG,EM,MAG GL	13	1969-1970	private geological maps	Cu, Ni	po,pent,cp,cn, mag
		•	51°28'36"	90°19'36"	AEM,AMG,EM,MAG, GL	7	1969-1970	AFRO R.18, R.20, 63.2648	Cu, Ni	po,cp
		•	51°27'36"	90°23'12"	AEM,AMG,MAG, GL		1970	private geol. maps, Shklanka (1969, p.177) private geol. map		po,py

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATI-TUDE	LONG-ITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
KAPKICHI LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°29'09"	90°19'36"	AEM,AMG,EM,MAG GL	13	1970	private geol. map, report	Cu, Ni	po,py,pent,cp, cn,mag
		•	51°28'51"	90°19'18"	AEM,AMG,EM,MAG, GL	5	1970	private geol. map, report	Cu, Ni	po,py,pent,cp, cn,mag
		•	51°29'00"	90°21'12"	AEM,AMG,EM,MAG, GL	1	1970	private geol. map		po,py,mag,hem
		•	51°28'48"	90°22'18"	AEM,AMG,EM,MAG, GL	1	1970			po,py,mag,hem
		•	50°29'05"	90°19'30"	EM,MAG	6–4152'	1970	AFRO R.13, 2.442		po,cp,py,mag
		•	51°29'10"	90°20'00"	EM,MAG	1–731'	1970	AFRO R.13, 2.442		py
		•	51°28'53"	90°20'25"	EM,MAG	3–1492'	1970	AFRO R.13, 2.442		po,cp,py
		•	51°28'45"	90°20'10"	EM,MAG	3–1479'	1970	AFRO R.13, 2.442		po,cp,py
		•	51°28'40"	90°20'06"	EM,MAG	2–956'	1970	AFRO R.13, 2.442		po,cp,mag,py
			51°28'58"	90°19'40"	EM,MAG	1–501'	1970	AFRO R.13, 2.442		
		•	51°27'24"	90°23'09"	AEM,AMG,EM,MAG		1971	private geol. map		po,py,mag
		•	51°27'06"	90°23'48"	AEM,AMG,EM,MAG		1971	private geol. map		po,mag,cp,IF
		•	51°26'54"	90°19'36"	AEM,AMG,EM,MAG		1971	private geol. map		po,mag,py
		•	51°25'54"	90°24'30"	AEM,AMG,EM,MAG		1971	private geol. map		mag,po,py,IF
			51°28'40"	90°20'00"	EM,MAG	1–426'	1971	AFRO R.13, 2.442		
		•	51°29'50"	90°21'05"	EM,MAG	3–4054'	1971	AFRO R.13, 2.442		po,cp,py,mag
		•	51°29'40"	90°21'05"	EM,MAG	11–2712'	1972	AFRO R.14, 2.442	Cu 0.3-0.4%	po,cp
		•	51°29'50"	90°21'40"	EM,MAG	2–1002'	1972	AFRO R.14, 2.442		po,py
		•	51°29'50"	90°21'25"	EM,MAG	2–1474'	1972	AFRO 2.442		po,py,cp
			51°29'40"	90°20'40"	EM,MAG	1–2002'	1972	AFRO R.14, 2.442		
			51°25'00"	90°28'00"	AEM,AMG			AFRO 2.687		
		•	51°24'40"	90°27'40"		1–118'	1972	private drill logs		po,py
KAWASHE LAKE	Cochenour Willans Gold Mines Ltd.	•	51°15'50"	91°06'10"		2–202'	1970	AFRO R.12		py,po
		•	51°15'10"	91°04'30"		1–153'	1970	AFRO R.13	Au-tr, Ag-nil	po,py
		•	51°17'40"	91°07'50"		4–473'	1971	AFRO R.14		po,py
		•	51°15'05"	91°14'50"	EM,MAG	1–101'	1972	AFRO R.15, 2.1083		po,py,IF,cp
		•	51°15'05"	91°14'55"	EM,MAG	1–101'	1972	AFRO R.15		po,sp,cp,IF
		•	51°15'05"	91°14'40"	EM,MAG	1–101'	1972	AFRO R.15		IF,mag,po
		•	51°15'05"	91°15'00"	EM,MAG	1–230'	1972	AFRO R.15		IF,po
		•	51°15'05"	91°14'40"	EM,MAG	1–126'	1972	AFRO R.15		IF,po,mag,sp
		•	51°14'55"	91°14'43"	EM,MAG	1–152'	1972	AFRO R.15		po,py
		•	51°15'00"	91°14'17"	EM,MAG	1–142'	1972	AFRO R.15		po,py
		•	51°15'03"	91°13'10"	EM,MAG	1–113'	1972	AFRO R.15		po,py
			51°16'25"	91°06'50"	EM			AFRO 2.1083		
			51°16'02"	91°05'05"	EM			AFRO 2.1083		
			51°15'15"	91°02'40"	EM			AFRO 2.1083		
			51°15'30"	91°07'00"	EM			AFRO 2.1083		
			51°15'00"	91°07'30"	EM			AFRO 2.1083		

KAWASHE LAKE	New Jersey Zinc Explor. Co. Ltd.	•	51°22'00"	91°06'30"		5–557'	1963	AFRO R.10	Au nil-0.32 oz/ton Ag nil-0.12 oz/ton	po,py
		•	51°22'00"	91°08'30"		1–162'	1963	AFRO R.11	Au tr-0.12 oz/ton	py,cp
	Union Minier Explor. & Mining Corp. Ltd.	•	51°16'05"	91°00'45"		1–266'	1963	AFRO R.16		gf,py,po
		•	51°16'15"	91°00'53"		1–240'	1972	AFRO R.16		gf,py,po
			51°18'30"	91°06'50"		1–182'	1973	AFRO R.17		
		•	51°18'35"	91°06'45"		1–254'	1973	AFRO R.17		py,po
		•	51°18'10"	91°07'50"		1–275'	1973	AFRO R.17		py,po
		•	51°17'57"	91°06'25"		1–220'	1973	AFRO R.17		py,po,gf
		•	51°17'50"	91°06'05"		1–201'	1973	AFRO R.17		py,po,gf
		•	51°16'10"	91°01'25"			1973	E. Reeve, UMEX, pers. comm. Shklanka (1968, p.221)	Au 0.02 oz/ton	mag IF
	Ontario Division Mines	•	51°16'50"	91°02'50"			1972	Sage et al. (1973c)	Cu 0.15% Ni 0.15%	mag
		•	51°18'20"	91°04'00"			1972	Sage et al. (1973c)		py,po,mag
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°21'20"	91°11'20"		1–206'	1972	private drill logs		py,po
		•	51°21'00"	91°12'30"		1–200'	1972	private drill logs		py,po,cp
		•	51°20'40"	91°11'30"		1–150'	1972	private drill logs		py,mag
		•	51°20'40"	91°10'00"		1–200'	1972	private drill logs		gf
		•	51°20'20"	91°09'30"		2–537'	1972	private drill logs		py,po,gf
			51°19'20"	91°09'00"		1–251'	1972	private drill logs		
		•	51°19'20"	91°08'30"		1–250'	1972	private drill logs		py,gf
		•	51°15'10"	91°00'40"		1–257'	1972	private drill logs		py,po,gf
KECHEOKOGAN LAKE	Great Plains Dev. Co. Canada Ltd.	•	52°13'30"	90°54'06"	AEM,AMG,EM		1972	D.A. Sawyer, pers. comm. AFRO 2.1006		cp
		•	52°12'60"	90°56'25"	AEM,AMG,EM,MAG	1–133'	1972	D.A. Sawyer, pers. comm. AFRO 2.1006		po,cp
		•	52°12'60"	90°52'80"	AEM,AMG,EM,MAG	1–103'	1972	D.A. Sawyer, pers. comm. AFRO 2.1006		po
	Rio Tinto Canadian Explor. Ltd.	•	52°12'00"	90°47'00"	EM,GC		1962	Sage et al. (1973a) private company report	Au 0.10 oz/ton	py
					EM,GC		1972	Sage et al. (1973a) private company report	Au 0.08 oz/ton	py
	Ontario Division Mines	•	52°12'80"	90°42'25"			1972	Sage et al. (1973a) private company report	Cu 0.02%	py,cp
	Rio Tinto Canadian Explor. Ltd.	•	52°13'10"	90°50'00"	EM,DN,GC	1–72'	1962	private company files	Au nil-0.05 oz/ton Ag nil-0.06 oz/ton. Cu tr-0.15%	po,py,cp cp,Ag
		•	52°12'30"	90°45'70"		2–817'	1965	AFRO R.10 private company file	Au nil-0.20 oz/ton Ag nil-0.18 oz/ton	py,po,cp
	Great Plains Dev. Co. Canada Ltd.	•	52°13'10"	90°50'00"	AEM,AMG,ARA	1–110'		D.A. Sawyer, pers. comm., AFRO 2.1006		

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATI-TUDE	LONG-ITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
LITTLE OCHIG LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°19'40"	90°26'00"		1-251'	1972	private drill logs		py,po,cp
		•	51°19'30"	90°25'00"		1-349'	1972	private drill logs		py,po,cp
		•	51°19'20"	90°24'30"		1-199'	1972	private drill logs		py
		•	51°16'00"	90°23'40"		1-148'	1972	private drill logs		py,po
		•	51°16'00"	90°22'20"		1-161'	1972	private drill logs		py,po
LOWRY LAKE	Canadian Nickel Co.Ltd.	•	51°06'36"	89°58'45"		2-269'	1971			po,py,asp,gf,cp
		•	51°05'48"	89°57'06"		1-190'	1971			po,py,mag
			51°05'36"	89°57'18"		1-168'	1971			po,py
	Hudson Bay Explor. & Dev. Co. Ltd.				AMG,ARA,MAG,GC		1970	private drill records		
		•	51°06'40"	89°56'30"		2-852'	1970	private drill records		py,po
		•	51°07'00"	89°55'00"		4-1575'	1970	private drill records		py,po,gf
		•	51°06'00"	89°54'30"		4-1636'	1970	private drill records		py,po
		•	51°06'20"	89°53'00"		3-1126'	1970	private drill records		py,po
		•	51°06'30"	89°50'30"		2-757'	1970	private drill records		py,po
		•	51°05'40"	89°49'30"		3-1098'	1970	private drill records		py,po,gf
		•	51°03'20"	89°53'40"		2-803'	1970	private drill records		po
		•	51°03'30"	89°55'30"		1-397'	1970	private drill records		po,gf
		•	51°03'00"	89°54'40"		1-397'	1970	private drill records		po,gf
		•	51°01'40"	89°49'20"		1-349'	1970	private drill records		po,py
		•	51°06'40"	89°44'30"		7-1398'	1970	private drill records		po,py,cp,sp,gf
MATAPESA-TAKUN BAY	Ontario Dept. Mines	•	51°11'50"	90°43'15"			1935	Harding (1936, p.69) Vokes (1963, p.71)		mo
MCVICAR LAKE	Belore Mines Ltd.		51°35'50"	91°29'00"		2-1152'	1969	AFRO R.15		
		•	51°35'50"	91°30'00"		2-562'	1970	AFRO R.16		py,po,cp
		•	51°36'10"	91°28'00"		1-263'	1970	AFRO R.20		po,py
	Card Lake Copper Mines Ltd.	•	51°37'10"	91°29'30"		2-1424'	1970	AFRO R.18		mag,IF,po,py
		•	51°37'00"	91°29'00"		1-675'	1970	AFRO R.18		po,py,cp
	Dresden Mines Ltd.		51°32'20"	91°27'00"	GL		1972	company report		
	Kennew Mines Ltd.	•	51°32'20"	91°27'10"		5-1175'	1959	AFRO R.12		py,Au,cp
		•	51°34'00"	91°23'20"	EM,SP	4-726'	1959	SMDR 503, AFRO 63.6563: R.10; 63.1164		py
	Kerr Addison Gold Mines Ltd.	•	51°34'00"	91°20'20"	EM,MAG	2-435'	1962	company report SMDR 503, AFRO R.11 63.6563	Cu 0.13-0.96% Ni 0.08-0.26%	po,cp
	Lang Lake Property	•	51°35'30"	91°30'40"				Mineral Resources Div., EMR		mo

MCVICAR LAKE	New Jersey Zinc Co.	•	51°33'30"	91°20'03"	EM,MAG,GC,GL	5–699'	1971	private report, SMDR 503, AFRO 63.6563	Cu, Ni, Ag, Au Pd, Co	po,py,cp, variolite
	Pickle Patricia Explor. Ltd.	•	51°32'10"	91°26'40"		3–1126'	1954	AFRO R.13	Au nil-0.11 oz/ton	py,IF,mag,asp
		•	51°30'30"	91°23'30"		3–1812'	1962	AFRO R.14	Au nil	sp,cp,py
		•	51°30'30"	91°24'10"		1–300'	1962	AFRO R.13		po,mag,IF
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°35'25"	91°24'25"		1–200'	1973	AFRO R.24		gf,py
		•	51°25'30"	91°21'50"		1–503'	1973	AFRO R.24		gf,py,po
	Smith-Watson Group	•	51°34'45"	91°27'00"				Laird (1931, p.18-19) Ferguson (1971, p.246)	Au 0.43 oz/ton over 3'	py,cp,asp,gn
	The Hanna Mining Co. Ltd.	•	51°35'15"	91°23'45"	GL		1971	AFRO files		py,po,gf
		•	51°35'30"	91°29'25"			1930	Laird (1931, Map 39g)		mo
	Ontario Division Mines	•	51°30'50"	91°29'30"			1972	Sage et al. (1973c)		py
MCCULLAGH TOWNSHIP	Canadian Nickel Co. Ltd.	•	51°32'24"	89°54'30"		1–171'	1971	AFRO D.D.10		po,py
		•	51°32'12"	89°55'06"		1–173'	1971	AFRO D.D.10		po,py,gf
	Crowshore Patricia Gold Mines Ltd.	•	51°31'30"	90°01'15"			1937-1946	Thompson (1938, p.50) Pye (1956, p.151-162)	Au	py,po
		•	51°31'30"	90°00'45"			1937-1946	Thompson (1938, p.50) Pye (1956, p.151-162)	Au	po
	Maloney Group	•	51°30'42"	89°58'00"			1930	Hurst (1930 p.25)		py,po,cp
			51°30'30"	89°59'30"			?	Jackson (1961)	Au	
	Mining Corp. Canada Ltd. (Manderson Phelps Group)	•	51°29'42"	89°58'15"			1930	Hurst (1930, p.27)		po,py,cp
	Roeanor Gold Mines Ltd.	•	51°28'54"	90°01'24"			1936	Thompson (1938, p.64)	Au	asp,py,po,cp
		•	51°28'54"	90°02'09"			1936	Thompson (1938, p.64)		py
MEEN LAKE	Jorsco Explor. Ltd.	•	51°28'12"	91°23'51"	EM,MAG,GL		1962	Shklanka (1968); AFRO 63.1157	Au 0.02 oz/ton	py
		•	51°28'39"	91°24'45"	EM,MAG,GL		1962	AFRO 63.1157		mag-py IF
	Ontario Division Mines	•	51°27'54"	91°25'12"			1972	Sage et al. (1973c)		mag-py IF
		•	51°26'30"	91°22'45"			1972	Sage et al. (1973c)		py
		•	51°25'54"	91°25'30"			1972	Sage et al. (1973c)		mag-py IF
							1972	Sage et al. (1973c)	Au 0.02 oz/ton	
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°25'50"	91°18'25"		1–250'	1972	AFRO R.10		py,po,mag

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
MEEN LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°25'20"	91°18'20"		2–275'	1972	private drill logs		py,po
		•	51°23'40"	91°15'30"		1–250'	1972	private drill logs		mag
		•	51°24'00"	91°18'30"		1–259'	1972	private drill logs		py,po
		•	51°23'40"	91°18'30"		1–528'	1972	private drill logs		mag
NABEMAKOSEKA LAKE	Cochenour Willans Gold Mines Ltd.	•	51°15'20"	91°22'10"		4–460'	1970	AFRO R.10		py,po
		•	51°15'20"	91°21'30"		2–115'	1970	AFRO R.11		py
		•	51°15'25"	91°22'40"		2–226'	1972	AFRO R.10		gf,py
		•	51°15'15"	91°22'35"		1–126'	1972	AFRO R.10		po,py,sp,cp
		•	51°15'15"	91°15'00"	EM,MAG	1–230'	1972	AFRO R.11; AFRO 2.1212		po,py,cp,sp
		•	51°15'15"	91°15'08"	EM,MAG	1–208'	1972	AFRO R.11; AFRO 2.1212		po,py,cp,IF
		•	51°15'15"	91°15'12"	EM,MAG	1–143'	1972	AFRO R.11; AFRO 2.1212		po,py,cp,IF,mag
		•	51°15'10"	91°15'20"	EM,MAG	1–101'	1972	AFRO R.11; AFRO 2.1212		po,py,cp
		•	51°15'15"	91°15'00"	EM,MAG	1–245'	1972	AFRO R.11; AFRO 2.1212		po,py,mag,sp
		•	51°15'05"	91°15'25"	EM,MAG	1–101'	1972	AFRO R.11; AFRO 2.1212		po,py,cp
			51°15'10"	91°24'20"	EM,MAG			AFRO 2.1212		
			51°16'50"	91°23'25"	MAG			AFRO 2.1212		
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°22'25"	91°15'25"		1–350'	1972	AFRO R.12		py,po
NORTH OF WAPAMISK CREEK	Great Plains Dev. Co. Canada Ltd.	•	52°15'53"	90°33'15"	AEM,AMG,EM	3–1268'	1972	AFRO 2.1069		po,py,cp
		•	52°15'40"	90°32'50"	AEM,AMG,EM	1–395'	1971	AFRO 2.1069		po,py
		•	52°15'15"	90°32'50"	AEM,AMG,EM	4–1910'	1971	AFRO 2.1069		po,py,cp,bn
OSNABURG LAKE	Ontario Division Mines	•	51°12'36"	90°14'18"			1972	Sage et al. (1973c)		py
	Canadian Nickel Co. Ltd.	•	51°07'40"	90°11'30"		2–690'	1971	AFRO R.10		py,po,gf,cp
		•	51°09'15"	90°04'40"		1–130'	1971	AFRO R.11		po,py,cp
OTOSKWIN RIVER	Ben Ohman	•	51°41'00" (location approximate)	90°13'00"			1972		Au 0.02 oz/ton Ag 1.5 oz/ton (sediment sample taken from Otoskwin River on Ben Ohman's claim group; assay by ODM)	
PICKLE CROW	Union Miniere Explor. & Mining Corp. Ltd.	•	51°24'40"	90°04'30"		1–150'	1972	private drill logs		po,py,gf
			51°30'00"	90°12'00"		1–357'	1972	private drill logs		

PONSFORD LAKE	Conwest Explor. Co. Ltd.		51°32'10"	90°18'00"	EM,MAG			file 2.677		
		•	51°30'06"	90°12'00"		1–400'	1971		Au tr-0.01 oz/ton	py,gf
		•	51°29'45"	90°12'24"		1–400'	1971			po,py
		•	51°30'30"	90°13'54"		1–160'	1971			po,py,cp
		•	51°30'00"	90°12'30"		1–221'	1971			po,py,cp
	Union Miniere Explor. & Mining Corp. Ltd. (Thierry Deposit)	•	51°30'30"	91°17'54"	AEM,AMG,GL		1970	UMEX private geol. map; AFRO 2.442		po
		•	51°30'00"	90°20'48"	AEM,AMG,EM,MAG, GL	77–45000'	1970	AFRO 2.442; AFRO R.21	Cu,Ni,Pt,Pd,Ag	po,cp,pent,ml, mag,il,vio,mac
		•	51°29'48"	90°19'00"	AEM,AMG,EM,MAG GL	1	1970	UMEX private geol. map (DDH K168)		gf
		•	51°29'48"	90°18'00"	AEM,AMG,EM,MAG GL	1	1970	UMEX private geol. map (DDH K163)		po,py
		•	51°29'09"	90°24'00"	AEM,AMG,EM,MAG GL	1	1970	UMEX private geol. map (DDH K98)		po,py,cp
		•	51°30'20"	90°20'25"		2–2535'	1971	AFRO R.10		py,po,mag,cp
		•	51°30'10"	90°20'40"		3–3952'	1971	AFRO R.10		po,cp,mag,py
		•	51°30'25"	90°17'15"		2–1624'	1971	AFRO R.10		po,cp
		•	51°30'10"	90°21'03"		2–2761'	1971	AFRO R.10		cp,po
			51°30'25"	90°17'55"		1–515'	1971	AFRO R.10		
		•	51°30'10"	90°20'25"		5–4067'	1971	AFRO R.10		py,po,cp,mag
		•	51°30'40"	90°17'55"		2–2962'	1971	AFRO R.10		py,po,cp
		•	51°30'25"	90°17'35"		8–2401'	1971	AFRO R.10		po,cp,py
		•	51°30'25"	90°16'30"		2–1236'	1971	AFRO R.10		py,cp,po,mag
		•	51°30'25"	90°16'15"		1–699'	1971	AFRO R.10		mag,cp
		•	51°30'25"	90°15'50"		2–1298'	1971	AFRO R.10		mag,py,po
			51°30'25"	90°15'30"		1–501'	1971	AFRO R.10		
		•	51°30'25"	90°16'25"		2–1067'	1971	AFRO R.10		mag
			51°30'25"	90°15'10"		1–435'	1971	AFRO R.10		
		•	51°30'40"	90°17'35"		1–1496'	1972	AFRO R.10		po,cp,py
			51°34'10"	90°16'25"		1–323'	1972	AFRO R.11		
			51°33'20"	90°17'00"	AEM,AMG			AFRO 2.544		
			51°30'30"	90°15'40"	AEM,AMG			AFRO 2.544		
			51°30'10"	90°17'50"	EM,MAG			AFRO 2.442		
	Conwest Explor. Co. Ltd.	•	51°30'10"	90°12'00"		1–400'	1971		Au tr-0.01 oz/ton	py,gf
		•	51°29'75"	90°12'40"		1–400'	1971			po,py
	Canadian Nickel Co. Ltd.	•	51°30'50"	90°13'90"		1–160'	1971			py,po,cp
		•	51°30'00"	90°12'50"		1–221'	1971			po,py,cp
RIACH LAKE	The Algoma Steel Corp. Ltd.	•	51°03'00"	90°23'00"		2–558'	1972	AFRO R.12		IF,mag,hem
		•	51°04'20"	90°20'20"	MAG	3–773'	1973	AFRO R.14; AFRO 2.919		IF
	Selco Explor. Co. Ltd.	•	51°01'20"	90°20'40"		1–311'	1971	Selco private report		po,cp
		•	51°01'30"	90°19'40"		1–316'	1971	Selco private report		po,py,gf
		•	51°02'10"	90°20'10"		1–330'	1971	Selco private report		po,py,gf
	Steerola Explor. Ltd.		51°05'	90°30'	GL			Steerola private report		
		•	51°02'40"	90°28'30"						Fe,mag-hem,IF

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
SOUTH OF NANOS LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°28'30"	90°38'15"		1–337'	1973	AFRO R.10		po
		•	51°29'10"	90°40'50"		1	1973	UMEX private drill records		po
		•	51°28'00"	90°40'20"		1	1973	UMEX private drill records		po,py
		•	51°28'00"	90°40'35"		1	1973	UMEX private drill records		po
		•	51°27'10"	90°40'20"		1	1973	UMEX private drill records		py
		•	51°25'55"	90°40'03"		1	1973	UMEX private drill records		po,py,mag
		•	51°25'12"	90°39'20"		1	1973	UMEX private drill records		po,py
			51°24'35"	90°38'50"		1	1973	UMEX private drill records		
			51°28'35"	90°38'50"		1	1973	UMEX private drill records		
		•	51°29'00"	90°40'30"		1–214'	1972	private drill logs		po
			51°27'10"	90°40'00"		1–468'	1972	private drill logs		
		•	51°25'40"	90°40'00"		1–156'	1972	private drill logs		py,po,mag
		•	51°25'30"	90°37'30"		1–132'	1972	private drill logs		py,po
		•	51°25'00"	90°39'00"		1–352'	1972	private drill logs		py,po,cp
SNOWFLAKE LAKE	Canadian Nickel Co. Ltd.	•	51°34'40"	89°07'20"		1–125'	1971	AFRO R.10		po,py,mag
		•	51°30'10"	89°01'20"		1–225'	1972	AFRO R.11		po,py,mag,sp, asp
		•	51°30'35"	89°02'30"		1–227'	1972	AFRO R.11		mag,py
		•	51°30'50"	89°00'40"		1–171'	1972	AFRO R.11		po,py
		•	51°32'45"	89°04'20"		1–274'	1972	AFRO R.12		po,py,mag,sp
STOUGHTON LAKE	The Algoma Steel Corp. Ltd.		51°36'00"	91°35'00"		1–56'	1968	AFRO R.14		
		•	51°36'00"	91°35'00"		4–380'	1968	AFRO R.14		IF,py,po
		•	51°36'30"	91°35'00"		2–393'	1968	AFRO R.14		py,asp,cp
		•	51°36'30"	91°35'06"		2–350'	1969	AFRO R.14		IF,py
		•	51°36'30"	91°35'00"		2–278'	1969	AFRO R.14		IF
		•	51°36'30"	91°35'00"		5–430'	1970	AFRO R.14		mag,py,po,IF
		•	51°36'30"	91°35'00"		4–364'	1970	AFRO R.14		mag,py,po,IF
		•	51°36'30"	91°35'20"		1–398'	1971	AFRO R.14		mag,IF,py,po
			51°36'30"	91°35'20"		2–414'	1971	AFRO R.14		
		•	51°36'30"	91°35'20"		1–563'	1971	AFRO R.14		po,cp,mag
	Bochawna Copper Mines Ltd.	•	51°35'40"	91°36'30"	EM	5–3277'	1968	AFRO R.10	Ag nil-2.03 oz/ton Cu 0.02-4.20% Mo nil-0.73%	py,cp,po,mo
		•	51°35'40"	91°36'30"		1–800'	1968	AFRO R.10	Ag 0.02-0.17 oz/ton Cu 0.01-0.45%	
		•	51°35'40"	91°36'30"		2–1402'	1968	AFRO R.10	Ag nil-0.78 oz/ton Cu 0.04-2.48% Mo nil-0.50%	
		•	51°35'40"	91°36'30"	EM	2–1535'	1969			

	The Hanna Mining Co.	•	51°35'40"	91°36'30"		9–4194'	1970	AFRO R.13		py,cp,po,sp,mo
		•	51°34'30"	91°37'20"		1–406'	1971	AFRO R.15		gf,po,py
		•	51°35'20"	91°38'20"		1–356'	1971	AFRO R.16		py,po,mag
		•	51°35'40"	91°32'30"		1–404'	1971	AFRO R.17		py,po
	Sulmac Explor. Co.		location unknown			1–336'	1960	AFRO R.10	Au tr Cu 0.03-0.26% Ni nil-0.02% Zn 0.05-2.18%	py,po,cp
			location unknown			1–316'	1960	AFRO R.11	Au tr Cu 0.01% Ni tr Zn 0.02%	po,py,cp
			location unknown			2–593'	1960	AFRO R.12	Au tr-0.13 oz/ton Cu 0.03-0.15% Ni nil-0.02% Zn nil-0.05%	mag,py,po
	Dumond, A.E.		51°33'50"	91°30'30"			1928	Laird (1930, p.20-21)		py,cp,ank
TARP LAKE	Conwest Explor. Co. Ltd.		51°32'20"	90°13'00"	AEM,AMG		1971	AFRO 2.677		
	James Bay Mining Corp.		51°30'40"	90°05'30"	EM		1972	AFRO 2.805		
	Metcalfe Group (mining company unknown)	•	51°33'20"	90°03'48"			1930	Hurst (1930, p.26-27)	Au	py,cp
	Transterre Explor. Ltd.		51°34'00"	90°04'30"	EM,MAG		1972	AFRO 2.756		
	Union Miniere Explor. & Mining Corp. Ltd.		51°30'30"	90°00'10"	AEM,AMG		1971	AFRO 2.544		
			51°34'00"	90°01'30"	AEM,AMG		1971	AFRO 2.544		
			51°32'00"	90°10'00"	AEM,AMG		1971	AFRO 2.544		
			51°34'00"	90°13'30"	AEM,AMG		1971	AFRO 2.544		
		•	51°30'30"	90°12'30"	AEM,AMG		1971	AFRO 2.544		
		•	51°31'00"	90°10'20"		1–402'	1971	AFRO R.20; AFRO 2.544		py,po
		•	51°30'10"	89°10'30"		1–493'	1972	private drill logs		py,po
		•	51°30'20"	89°10'30"		1–427'	1972	private drill logs		py,po,gf
		•	51°30'10"	89°10'10"		1–477'	1972	private drill logs		py,po,gf
		•	51°30'30"	90°14'00"		1–549'	1972	private drill logs		mag
		•	51°31'10"	90°14'30"		1–390'	1972	private drill logs		po,py
			51°30'40"	90°12'30"		1–432'	1972	private drill logs		py,po
		•	51°30'40"	90°12'10"		1–402'	1972	private drill logs		
		•	51°33'40"	90°00'40"		1–430'	1972	private drill logs		py,po,gf
			51°33'50"	90°02'00"		1–704'	1972	private drill logs		gf
		•	51°02'10"	90°02'30"		1–92'	1972	private drill logs		
			51°33'40"	90°13'00"		2–257'	1972	private drill logs		py,po,gf
						1–150'	1972	private drill logs		
UPPER WINDIGO LAKE	No record of ownership	•	52°28'30"	91°39'00"			circa 1928	Satterly, (1941, p.27)		Au,cp,py-in quartz vein

TOWNSHIP OR AREA	NAME	DEPOSIT OR EXPL. AREA	LATITUDE	LONGITUDE	TYPE OF WORK	DDH'S	APPROX. DATE	REFERENCES	ASSAYS OR ANALYSES	MINERALS
WAPAMISK CREEK	Great Plains Dev. Co. of Canada Ltd.	•	52°13'38"	90°30'33"	AEM,AMG,EM	1–418'	1971	AFRO 2.1069	Cu,Zn,Ni	po,py,mag
		•	52°13'42"	90°30'33"	AEM,AMG,EM	1–685'	1972	AFRO 2.1069	Cu,Zn,Ni	po,py
		•	51°13'55"	90°30'50"	AEM,AMG,EM	1–325'	1972	AFRO 2.1069	Cu,Zn,Ni	po,py
WIEBERG LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°29'50"	89°59'10"	AEM,AMG	1–513'	1971	AFRO R.10		po,py
		•	51°30'00"	90°58'40"		1–387'	1972	private drill logs		py,po
		•	51°29'30"	89°59'30"		1–200'	1972	private drill logs		po
			51°29'20"	90°58'50"		1–240'	1972	private drill logs		
WETTLAUFFER LAKE	Charles Boland (Card Lake Copper Mines Ltd.)		51°33'40"	90°59'40"		1–247'	1970	AFRO R.10; SMDR 000492		
		•	51°33'40"	90°59'40"		1–287'	1970	AFRO R.10; SMDR 000492		po,cp,py
WESLEYAN LAKE	Connell-Stirret Williams	•	51°10'50"	91°38'30"			1934	Harding (1936, p.73) Ferguson et al. (1971, p.245)	Au 0.15 oz/ton	po,cp,py,sp,gn, mo
	Philip Tivy	•	51°10'10"	91°36'40"			1927	Laird (1931, p.22-24)		py,cp,sp
	Ontario Division Mines	•	51°12'20"	91°45'00"			1972	Sage et al. (1973c)	Mo 0.36%	mo
		•	51°09'15"	91°34'00"			1972	Sage et al. (1973c)	Cu 0.10%	mo,cp,fl
								Sage et al. (1973c)	Mo 0.14%	
								Sage et al. (1973c)	F 0.10%	
		•	51°09'10"	91°35'50"			1972	Sage et al. (1973c)		mo
		•	51°08'20"	91°33'50"			1972	Sage et al. (1973c)		mo
		•	51°07'50"	91°33'10"			1972	Sage et al. (1973c)		mo
	Cochenour Willans Gold Mines Ltd. (Sanderson Option)	•	51°11'20"	91°32'30"		2–498'	1966	MNR Files, Red Lake (claim PA 36030)	Au tr-25.12 oz/ton Ag tr-6.24 oz/ton	py,cp,sp,gn, visible Au
		•	51°11'20"	91°32'25"		7–980'	1966	MNR Files, Red Lake (claim 35897)	Au 0.20 oz/ton Ag 2196 oz/ton over 1.5'	py,po,cp,tet, sp,gn
		•	51°11'40"	91°32'30"		1–150'	1972	AFRO R.12		po,py
		•	51°09'50"	91°35'30"		1–105'	1970	MNR Files, Red Lake		po,py,cp
		•	51°11'00"	91°32'50"			1966	private maps	Au, Ag	
		•	51°11'15"	91°31'30"			1966	private maps	Ag, Ag	
WRIGHT LAKE	Union Miniere Explor. & Mining Corp. Ltd.	•	51°17'05"	90°53'50"		1–144'	1972	AFRO R.10		po
		•	51°17'25"	90°47'25"		1–373'	1972	AFRO R.10		po,cp,sp,gf
		•	51°17'05"	90°47'30"		2–1234'	1972	AFRO R.10		po,gf,py,cp,sp
		•	51°17'25"	90°46'30"		2–1012'	1972	AFRO R.10		po,gf,py,cp,sp
		•	51°17'25"	90°47'25"		1–987'	1972	AFRO R.10		gf,po,py,cp
		•	51°17'10"	90°47'25"		1–371'	1972	AFRO R.10		po,py

		•	51°17'15"	90°47'30"		1–550'	1972	AFRO R.10	po
		•	51°17'20"	90°47'10"		1–513'	1972	AFRO R.10	po,py,Zn,cp
			51°17'15"	90°47'10"		1–289'	1972	AFRO R.10	
		•	51°17'25"	90°47'10"		1–437'	1972	AFRO R.10	
			51°16'10"	90°58'00"					po,py,gf
									py
	Newconex Canadian Explor. Ltd.		51°18'00"	89°46'50"	EM,GL		1969	AFRO 63.2807	
			51°16'55"	89°53'30"	EM,GL		1969	AFRO 63.2807	py,gf
			51°16'10"	89°57'50"	EM,GL		1969	AFRO 63.2807	py,gf
									py
	Union Miniere Explor. & Mining Corp. Ltd.	•	51°17'40"	90°44'00"		1–150'	1972	private drill logs	po
		•	51°17'00"	90°53'00"		1–144'	1972	private drill logs	po,py,gf
		•	51°18'00"	90°46'40"		1–272'	1972	private drill logs	py,po,cp,gf
		•	51°16'30"	90°58'40"		1	1972	private drill logs	po,py
		•	51°16'30"	90°57'20"		1	1972	private drill logs	py,po
			51°16'40"	90°53'40"		1–217'	1972	private dirll logs	
		•	51°15'30"	90°51'20"		1–145'	1972	private drill logs	py,gf
		•	51°18'00"	90°47'30"		1–146'	1972	private drill logs	po
		•	51°18'00"	90°46'40"		1–144'	1972	private drill logs	py
		•	51°17'20"	90°47'00"		1–162'	1972	private drill logs	py
			51°17'00"	90°47'20"		1–169'	1972	private drill logs	
ZIONZ LAKE	Fort Reliance Minerals Ltd.	•			GC,GL		1969	AFRO 2.41	po,py,cp
AREA 2499 UNNAMED	Ontario Division Mines	•	51°07'40"	91°32'00"			1972	Sage et al. (1973c)	mo

Abbreviations

Type of Work

AEM	Airborne electromagnetic survey
AMG	Airborne magnetometer survey
ARA	Airborne radiometric survey
DN	Dip needle survey
EM	Ground electromagnetic survey
GC	Geochemical survey
GL	Geological mapping
MAG	Ground magetometer survey
SP	Self potential Survey

DDH's Diamond drill holes

6-5334' Six holes totalling 5334 feet

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AFRO	Assessment Files Research Office, Ontario Geological Survey Toronto.
EMR	Energy, Mines and Resources, Canada
MNR	Regional or Resident Geologist's files, Ontario Ministry of Natural Resources files
NM	The Northern Miner
SMDR	Source Mineral Deposits Records, Ontario Geological Survey, Toronto

Assays, Minerals

Ag	Silver	hem	Hematite	Pt	Platinum
asp	Arsenopyrite	IF	Iron formation	py	Pyrite
Au	Gold	il	Ilmenite	qv	Quartz vein
Bi	Bismuth	mac	Mackinawite	RA	Radioactivity
bm	Bismuthinite	mag	Magnetite	shee	Scheelite
bn	Bornite	ml	Millerite	sp	Sphalerite
Co	Cobalt	Mo	Molybdenum	tet	Tetrahedrite
cp	Chalcopyrite	mo	molybdenite	Th	Thorium
Cu	Copper	Ni	nickel	U	Uranium
F	Fluorine	Pb	Lead	vio	Violarite
fl	Fluorite	Pd	Palladium	Zn	Zinc
gf	Graphite	pent	Pentlandite		
gn	Galena	po	Pyrrhotite		

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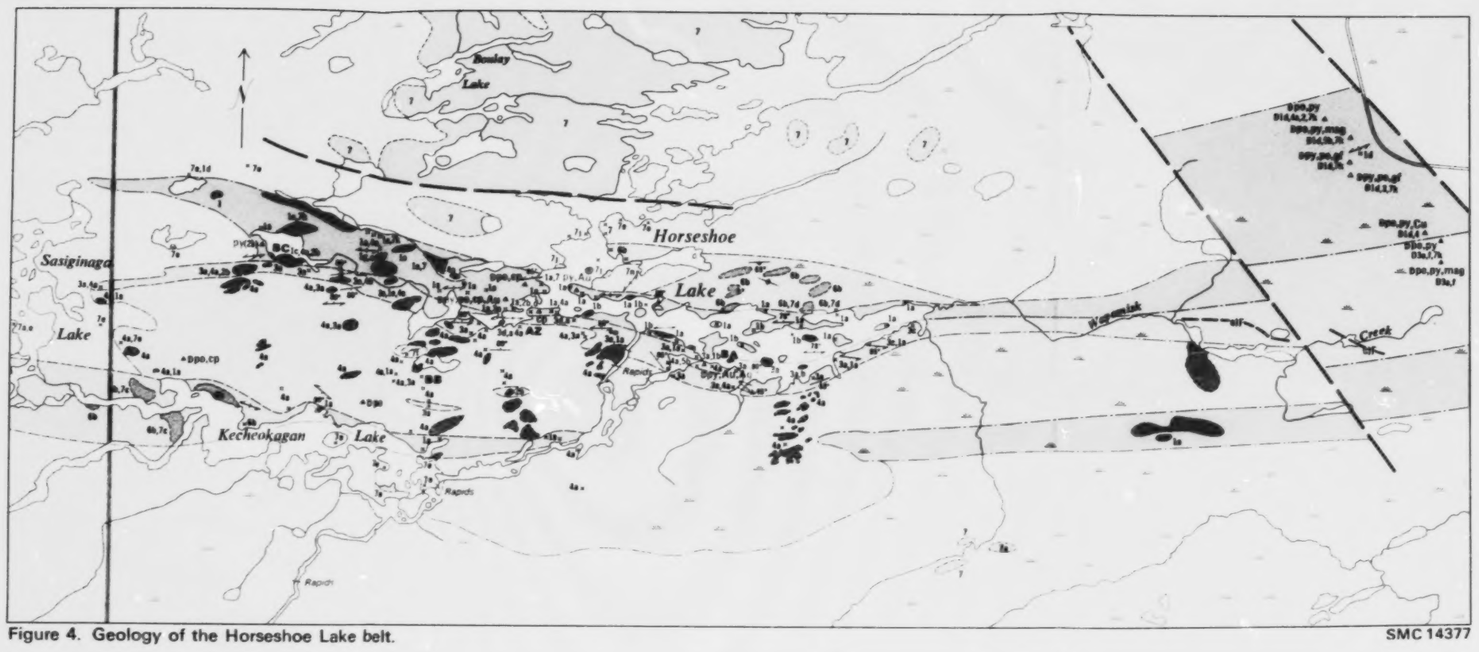

Figure 4. Geology of the Horseshoe Lake belt.

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Norbury Lake
Wesley Lake
Forester Lake
Boyce Lake
Neawagank Lake
Labreche Lake
Rapids
The topographic names "Sage Lake" and "Wesley Lake" are not approved by the Ontario Geographic Names Board, and are shown for reference only.

Figure 6. Geology of the Forester Lake belt.

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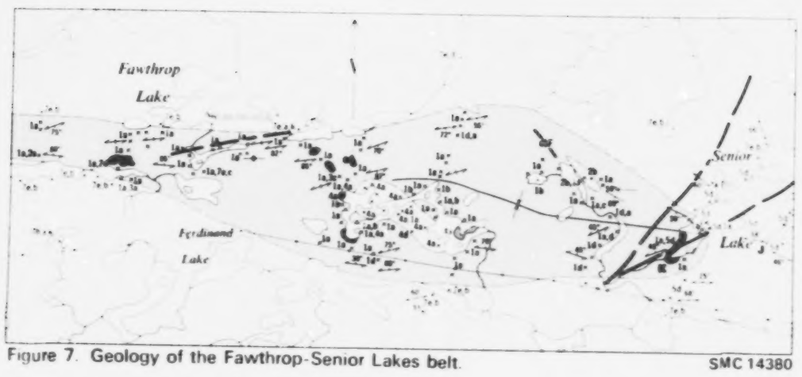

Figure 7. Geology of the Fawthrop-Senior Lakes belt.

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LEGEND

EARLY PRECAMBRIAN

FELSIC INTRUSIVE AND METAMORPHIC ROCKS

7 Unsubdivided.
7a Massive.
7b Foliated.
7c Gneissic.
7d Porphyritic or porphyroblastic.
7e Biotite and biotite-hornblende trondhjemite to quartz monzonite.
7f Hornblende and hornblende-biotite trondhjemite to quartz monzonite.
7g Hornblende and hornblende-biotite granite.
7h Biotite and biotite-hornblende granite.
7j Hornblende and hornblende-biotite granodiorite to quartz diorite.
7k Granitic pegmatite and aplite.
7m Hornblende and hornblende-biotite diorite.
7n Unsubdivided xenolithic.

INTRUSIVE OR GRADATIONAL CONTACT

MIGMATITIC ROCKS

6 Unsubdivided.
6a Biotite-quartz-feldspar gneiss (meta-sedimentary migmatite, >25% granitic material).
6b Hornblende-feldspar-quartz gneiss (metavolcanic migmatite, >25% granitic material).

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

5 Unsubdivided.
5a Quartz-feldspar porphyry.
5b Feldspar porphyry.
5c Quartz porphyry.
5d Fine grained, massive to foliated equigranular to porphyritic trondhjemite to dacite.

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

4 Unsubdivided.
4a Metagabbro.
4b Metadiorite to quartz diorite.
4c Anorthositic gabbro, gabbroic anorthosite, anorthosite.
4d Ultramafic rocks and their serpentinized equivalents.

INTRUSIVE CONTACT

METASEDIMENTS

3 Unsubdivided.
3a Quartzite, arkose, greywacke.
3b Conglomerate.
3c Shale, slate, argillite, siltstone.
3d Biotite-quartz-feldspar schist and gneiss (with minor hornblende and sericite).
3e Garnetiferous metasediments.
3f Sillimanite-bearing metasediments.
3g Andalusite-bearing metasediments.

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

2 Unsubdivided.
2a Rhyolite to dacite.
2b Tuff and lapilli tuff.
2c Agglomerate, breccia.
2d Porphyritic flow, quartz-feldspar porphyry.

MAFIC TO INTERMEDIATE METAVOLCANICS

1 Unsubdivided.
1a Basalt to andesite, massive to foliated.
1b Basalt to andesite, pillowed.
1c Mafic tuff, agglomerate.
1d Amphibolite.
1e Migmatized mafic metavolcanics (10-25% granitic material).
1g Variolitic basalt to andesite.
1h Flow top breccia.
1j Porphyritic basalt to andesite, foliated and/or massive.

IF Iron formation (associated with units 1, 2, and 3).

LEGEND

EARLY PRECAMBRIAN

FELSIC INTRUSIVE AND METAMORPHIC ROCKS

7 Unsubdivided.
7a Massive.
7b Foliated.
7c Gneissic.
7d Porphyritic or porphyroblastic.
7e Biotite and biotite-hornblende trondhjemite to quartz monzonite.
7f Hornblende and hornblende-biotite trondhjemite to quartz monzonite.
7g Hornblende and hornblende-biotite granite.
7h Biotite and biotite-hornblende granite.
7j Hornblende and hornblende-biotite granodiorite to quartz diorite.
7k Granitic pegmatite and aplite.
7m Hornblende and hornblende-biotite diorite.
7n Unsubdivided xenolithic.

INTRUSIVE OR GRADATIONAL CONTACT

MIGMATITIC ROCKS

6 Unsubdivided.
6a Biotite-quartz-feldspar gneiss (metasedimentary migmatite, >25% granitic material).
6b Hornblende-feldspar-quartz gneiss (metavolcanic migmatite, >25% granitic material).

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

5 Unsubdivided.
5a Quartz-feldspar porphyry.
5b Feldspar porphyry.
5c Quartz porphyry.
5d Fine grained, massive to foliated, equigranular to porphyritic trondhjemite to dacite.

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

4 Unsubdivided.
4a Metagabbro.
4b Metadiorite to quartz diorite.
4c Anorthositic gabbro, gabbroic anorthosite, anorthosite.
4d Ultramafic rocks and their serpentinized equivalents.

INTRUSIVE CONTACT

METASEDIMENTS

3 Unsubdivided.
3a Quartzite, arkose, greywacke.
3b Conglomerate.
3c Shale, slate, argillite, siltstone.
3d Biotite-quartz-feldspar schist and gneiss (with minor hornblende and sericite).
3e Garnetiferous metasediments.
3f Sillimanite-bearing metasediments.
3g Andalusite-bearing metasediments.

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

2 Unsubdivided.
2a Rhyolite to dacite.
2b Tuff and lapilli tuff.
2c Agglomerate, breccia.
2d Porphyritic flow, quartz-feldspar porphyry.

MAFIC TO INTERMEDIATE METAVOLCANICS

1 Unsubdivided.
1a Basalt to andesite, massive to foliated.
1b Basalt to andesite, pillowed.
1c Mafic tuff, agglomerate.
1d Amphibolite.
1e Migmatized mafic metavolcanics (10-25% granitic material).
1g Variolitic basalt to andesite.
1h Flow top breccia.
1j Porphyritic basalt to andesite, foliated and/or massive.

[illegible] formation associated with units

SYMBOLS

Glacial striae.

Small bedrock outcrop.

Area of bedrock outcrop.

Bedding, top unknown; (inclined, vertical).

Lava flow; top (arrow) from pillows shape and packing.

Gneissosity, (horizontal, inclined, vertical).

Foliation; (horizontal, inclined, vertical).

Lineation with plunge.

Geological boundary, position interpreted.

Geological boundary, deduced from geophysics.

Lineament or fault.

Prominent shearing.

Drag folds with plunge.

Anticline, syncline, with plunge.

Drill hole; (vertical, inclined).

Mineral occurrence.

AV Location of whole rock analysis.

Road.

Electric power transmission line.

Surveyed line, approximate position only.

Ag Silver.
asp Arsenopyrite.
Au Gold.
cp Chalcopyrite.
Cu Copper.
Fe Iron.
gr Graphite.
gn Galena.
hem Hematite.
mag Magnetite
mo Molybdenite.
Ni Nickel.
po Pyrrhotite.
py Pyrite.
q Quartz.
sp Sphalerite.
Tetrahedrite.

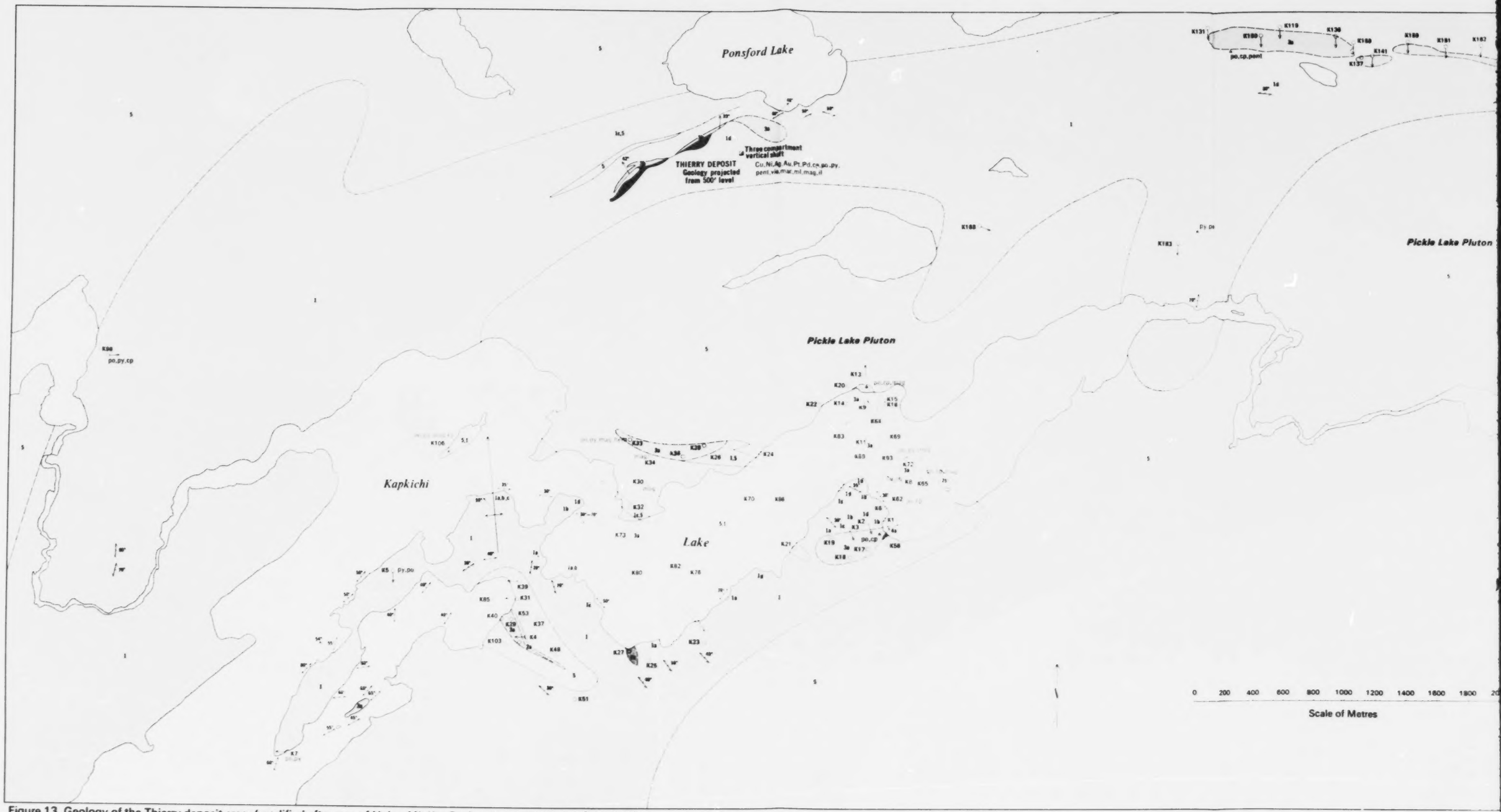
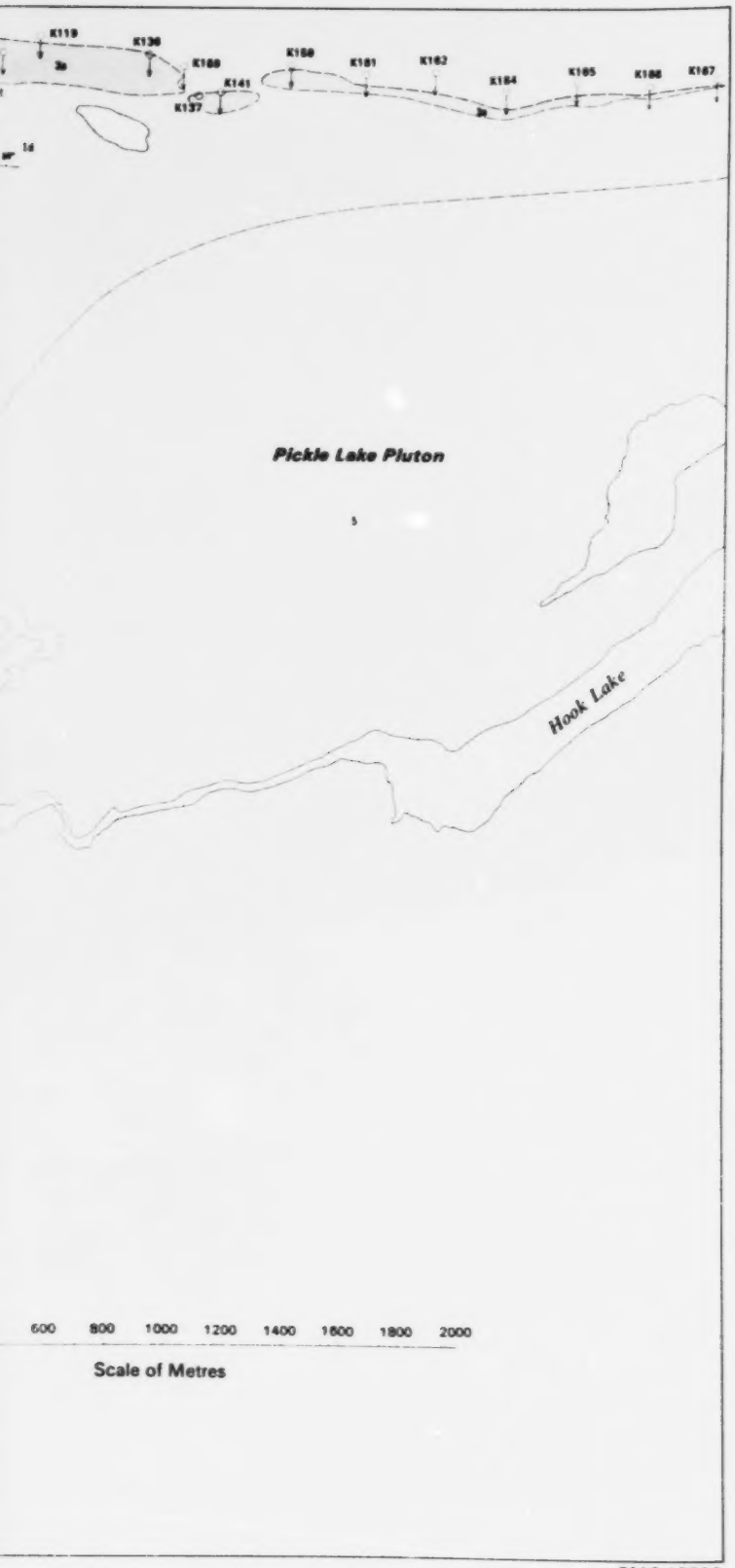


Figure 13. Geology of the Thierry deposit area; (modified after map of Union Minière Explorations and Mining Corp. Ltd.).



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GRANITIC ROCKS

5 — *5 Unsubdivided.*

MAFIC INTRUSIVE ROCKS

4a Gabbro, metagabbro.

ULTRAMAFIC INTRUSIVE ROCKS

3 — *3a Peridotite and altered equivalents.*
3b Biotite-chlorite-hornblende ultramafic schist.

METASEDIMENTS

2 — *2a Quartzo feldspathic (and garnetiferous) schists and gneisses.*

AMPHIBOLITES derived from volcanic (and pyroclastic and sedimentary?) rocks

1 — *1 Unsubdivided.*
1a Massive amphibolite.
1b Schistose and poorly banded amphibolite.
1c Strongly banded amphibolite.
1d Pillowed amphibolite.

Silver.	*Millerite.*
Gold.	*Nickel.*
Chalcopyrite.	*Palladium.*
Copper.	*Pentlandite.*
Hematite.	*Pyrrhotite.*
Ilmenite.	*Platinum.*
Mackinawite.	*Pyrite.*
Magnetite.	*Violarite.*

Bedding, top unknown.

Banding or schistosity.

Lineation with plunge.

Antiform.

Geological boundary.

K33 - K34 — *Drill hole; (vertical, inclined).*

Mineralization.

METAVOLCANICS

FELSIC TO INTERMEDIATE METAVOLCANICS

2 Undivided
2a Rhyolite to dacite
2b Tuff and lapilli tuff
2c Agglomeratic breccia
2d Porphyritic flow, quartz-feldspar porphyry

MAFIC TO INTERMEDIATE METAVOLCANICS

1 Undivided
1a Basalt to andesite, massive to foliated
1b Basalt to andesite, pillowed
1c Mafic tuff, agglomerate
1d Amphibolite
1e Magnetoid mafic metavolcanics (10-25% granitic material)
1g Variolitic basalt to andesite
1h Flow top breccia
1j Porphyritic basalt to andesite, foliated and/or massive

IF Iron formation (associated with units 1, 2, and 3)

Silver
Arsenopyrite
Gold
Chalcopyrite
Copper
Iron
Graphite
Galena
Hematite
Magnetite
Molybdenite
Nickel
Pyrrhotite
Pyrite
Quartz
Sphalerite
Tetrahedrite
Tungsten
Uranium

Map rock units, metals and minerals do not necessarily appear on each figure.

The letter 'C' preceding a map rock unit, metal or mineral reference indicates an occurrence not examined by field party. Information compiled from mining company files.

The letter 'D' indicates data from drill hole logs.

The letter 'G' indicates interpretation from geophysical data.

Geology by R. P. Sage and F. W. Breaks and assistants, Ontario Geological Survey, 1970, for Operation Pickle Lake.

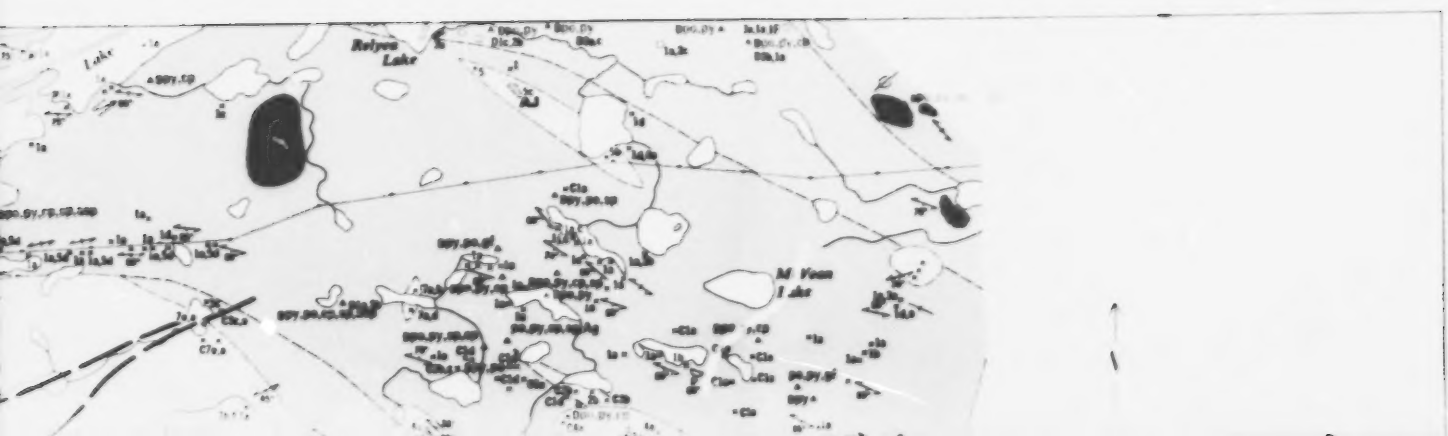
Assessment work on file with the Ontario Geological Survey.

Published reports of the Ontario Geological Survey.

Unpublished information courtesy of Canadian Malartic Ltd., Hudson Bay Exploration and Development Co. Ltd.

Scale 1: 125 000

Kilometres



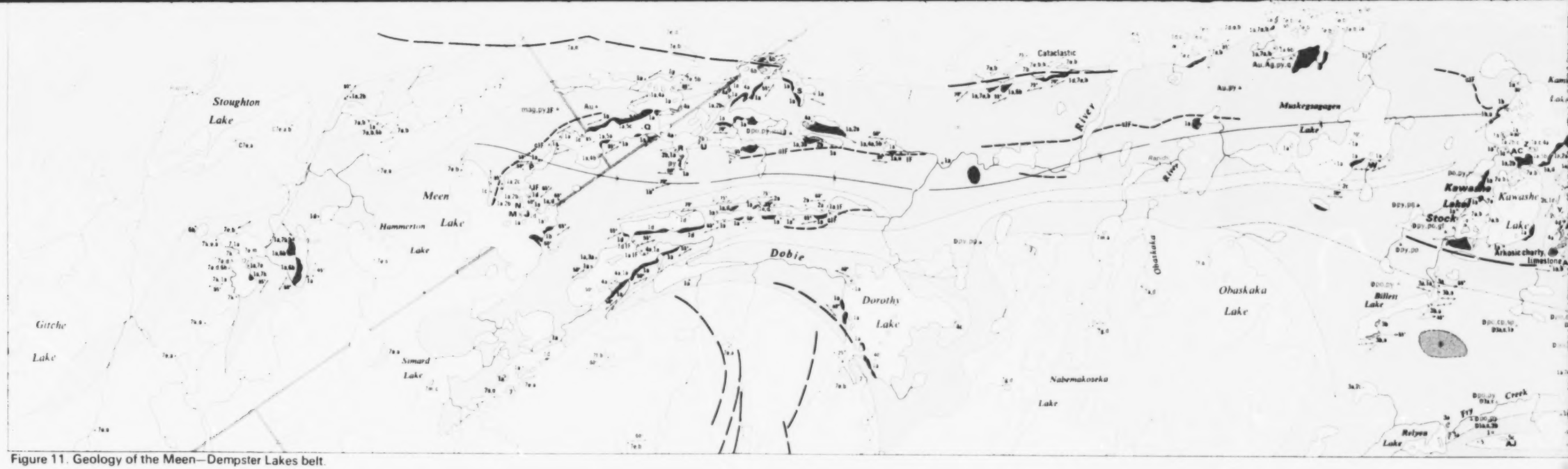
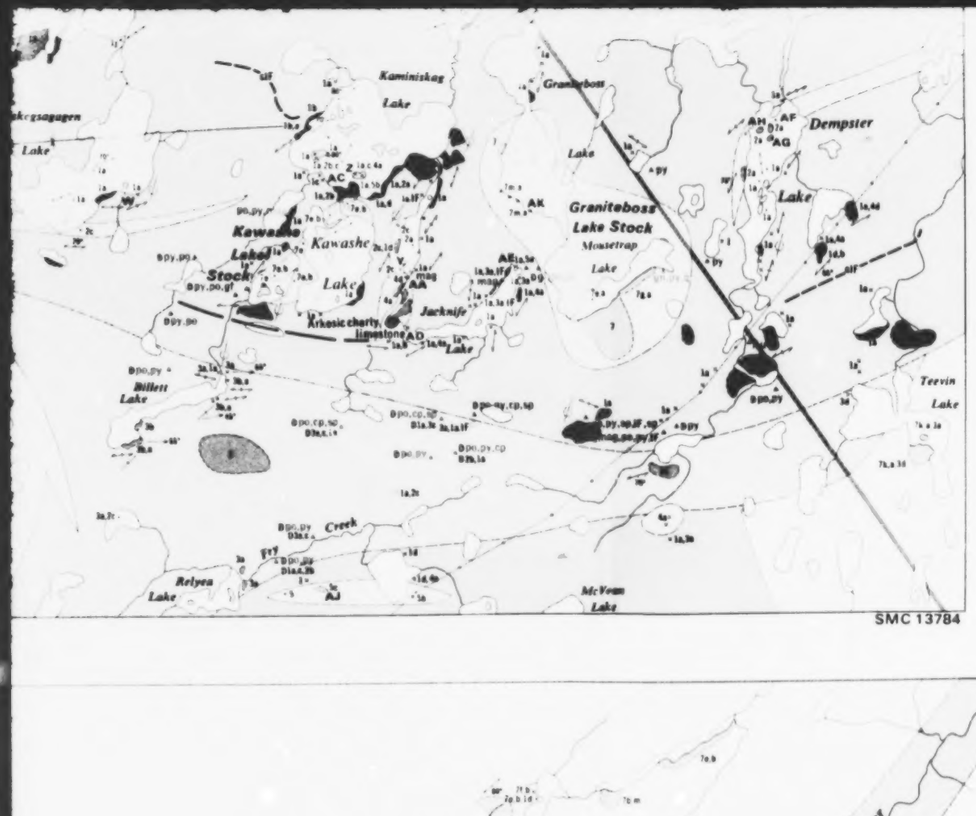


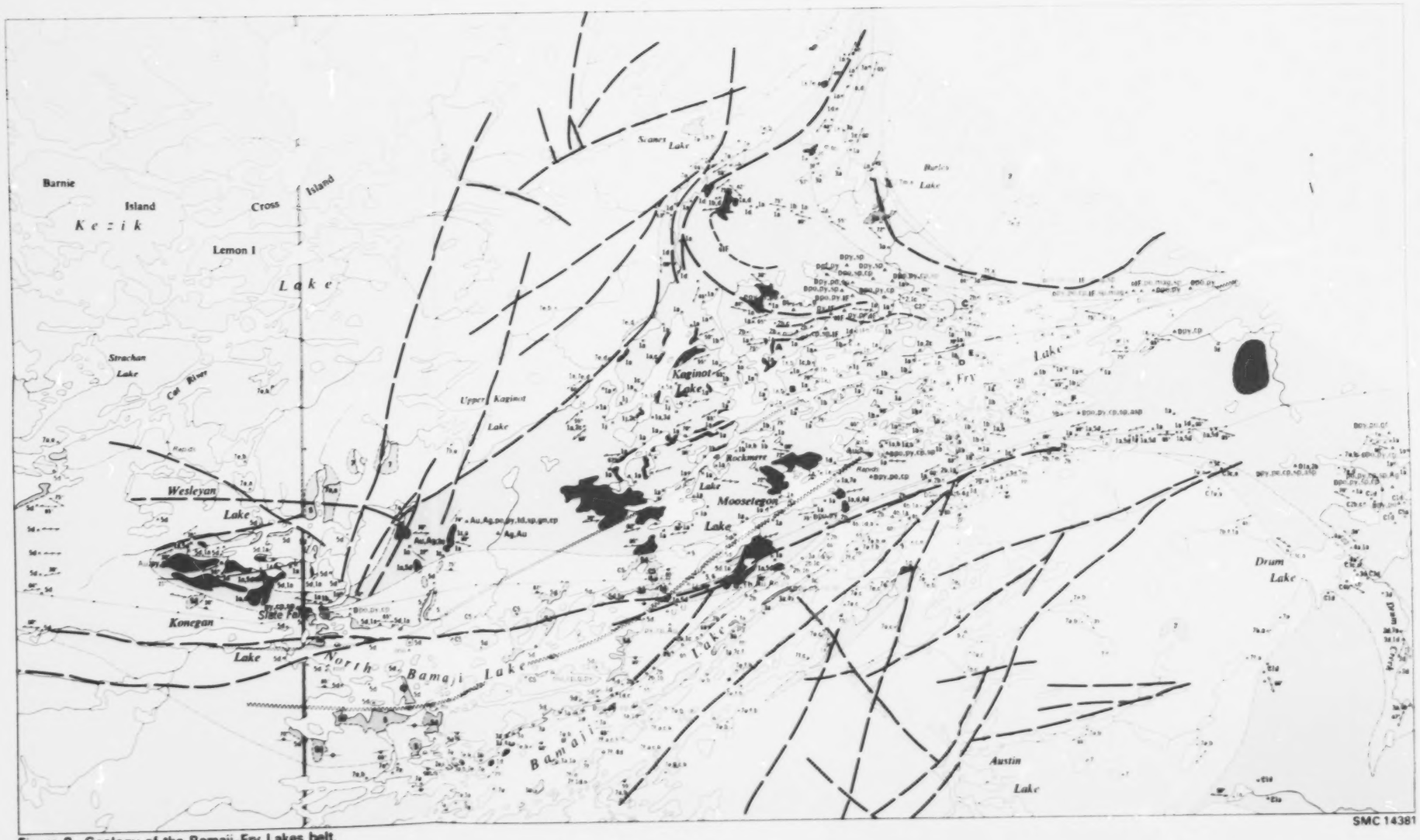
Figure 11. Geology of the Meen—Dempster Lakes belt.


Kaminiskag Lake
Granitoboss Lake
Dempster Lake
Kawashe Lake
Granitoboss Lake Stock
Monsetrap Lake
Stock
Jacknife Lake
Arkosic cherty limestone
Billett Lake
Teevin Lake
Creek
Relyea Lake
McVean Lake
SMC 13784

Heather Lake
River
Misehkow
Vallas Lake
Iron Falls
Magnetic attraction
Greenmantle River
Crozier Lake
Greenmantle

Figure 7. Geology of the Fawthrop-Senior Lakes belt

SMC 14380



SMC 14381

Figure 8. Geology of the Bamaji-Fry Lakes belt.

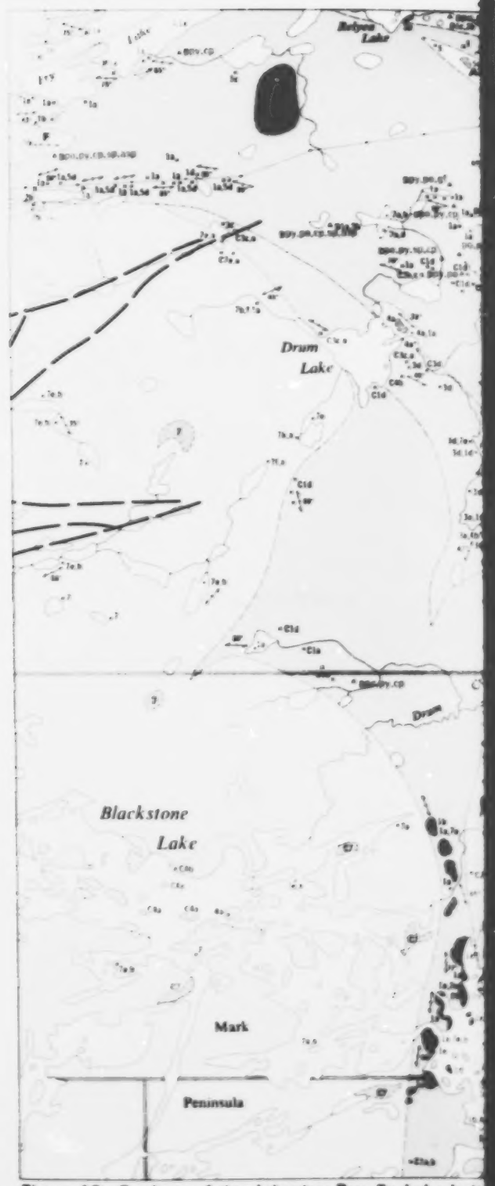


Figure 10. Geology of the Johnston Bay-Fry Lake belt.

10. Geology of the Johnston Bay-Fry Lake belt

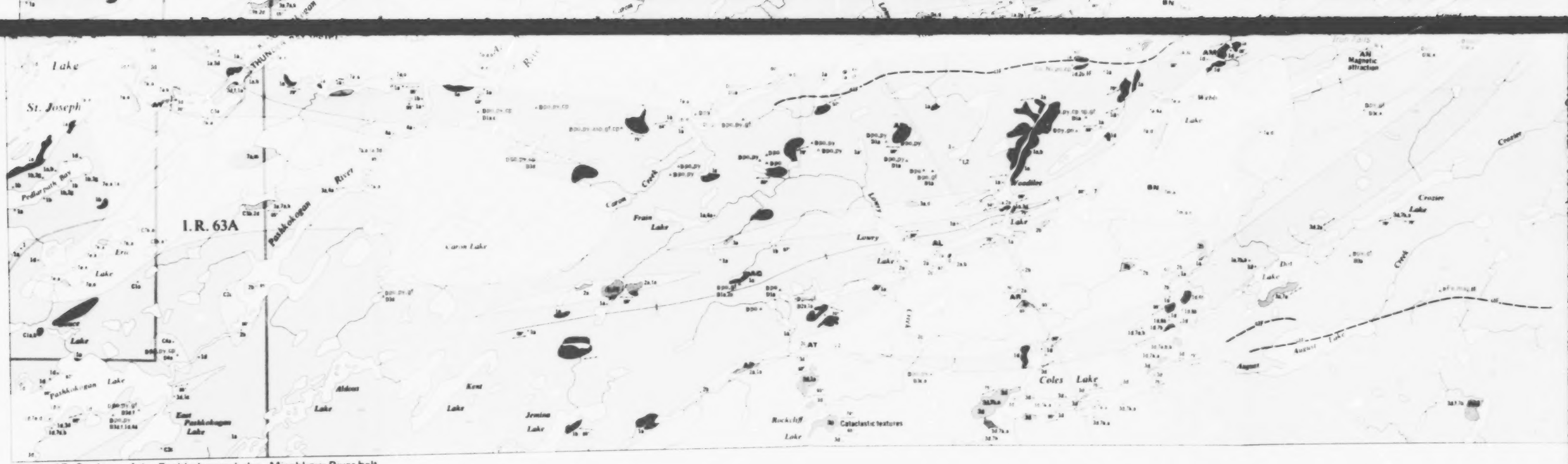


Figure 17. Geology of the Pashkokogan Lake—Misehkow River belt

LEGEND

MIDDLE TO LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS

8 Ra Diabase

INTRUSIVE CONTACT

EARLY PRECAMBRIAN
FELSIC INTRUSIVE AND METAMORPHIC ROCKS

7 Unsubdivided.
7a Massive.
7b Foliated.
7c Gneissic.
7d Porphyritic or porphyroblastic.
7e Biotite and biotite-hornblende monzonite to quartz monzonite.
7f Hornblende and hornblende-biotite monzodiorite to quartz monzonite.
7g Hornblende and hornblende-biotite granite.
7h Biotite and biotite-hornblende granite.
7i Hornblende and hornblende-biotite granodiorite to quartz diorite.
7k Granitic pegmatite and aplite.
7m Hornblende and hornblende-biotite quartz diorite.
7n Unsubdivided xenolithic.

INTRUSIVE OR GRADATIONAL CONTACT

MIGMATITIC ROCKS

6 Unsubdivided.
6a Biotite-quartz feldspar gneiss (metasedimentary migmatite, >25% granitic material).
6b Hornblende-feldspar-quartz gneiss (metavolcanic migmatite, >25% granitic material).

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

5 Unsubdivided.
5a Quartz-feldspar porphyry.
5b Feldspar porphyry.
5c Quartz porphyry.
5d Fine grained, massive to foliated, equigranular to porphyritic trondhjemite to dacite.

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS

4 Unsubdivided.
4a Metagabbro.
4b Metagabbro to quartz diorite.
4c Ultramafic (pyroxenite, peridotite and locally serpentinite).
4d Unequigranular rocks and their equivalent phases.

INTRUSIVE CONTACT

METASEDIMENTS

3 Unsubdivided.
3a Quartzite, greywacke.
3b Argillite.
3c Undifferentiated sediments.
3d Biotite-quartz-feldspar ± garnet and grunerite (with minor hornblende and cummingtonite).
3e Garnet-bearing metasediments.
3f Staurolite-bearing metasediments.
3g Andalusite-bearing metasediments.

METAVOLCANICS
FELSIC TO INTERMEDIATE METAVOLCANICS

2 Unsubdivided.
2a Rhyolite to dacite.
2b Tuff and lapilli tuff.
2c Agglomeratic breccia.
2d Porphyritic flow (quartz and/or feldspar porphyry).

MAFIC TO INTERMEDIATE METAVOLCANICS

1 Unsubdivided.
1a Basalt to andesite, massive to foliated.
1b Basalt to andesite, pillowed.
1c Mafic tuff, agglomerate.
1d Amphibolite.
1e Migmatized mafic metavolcanics (10-25% granitic material).
1g Variolitic basalt to andesite.
1h Flow top breccia.
1i Porphyritic basalt to andesite, foliated and/or massive.

IF Iron formation (associated with units 1, 2, and 3).

Mafic and ultramafic rocks undifferentiated, mainly gabbro and peridotite.

The letter (s) indicates a metasedimentary unit, (v) indicates a metavolcanic unit, and (x) indicates a unit partly metasedimentary and partly metavolcanic.

The letter (i) indicates rocks from drill hole logs.

The letter (g) indicates interpretation from geophysical data.

Modified after Ontario Geological Survey, 1970, Operation Pickle Lake.

Compiled in part with the Ontario Geological Survey.

Aeromagnetic data from the Ontario Geological Survey.

Unpublished information of Centremar Algoma Gold Mines Ltd., Hudson Bay Exploration and Development Co. Ltd.

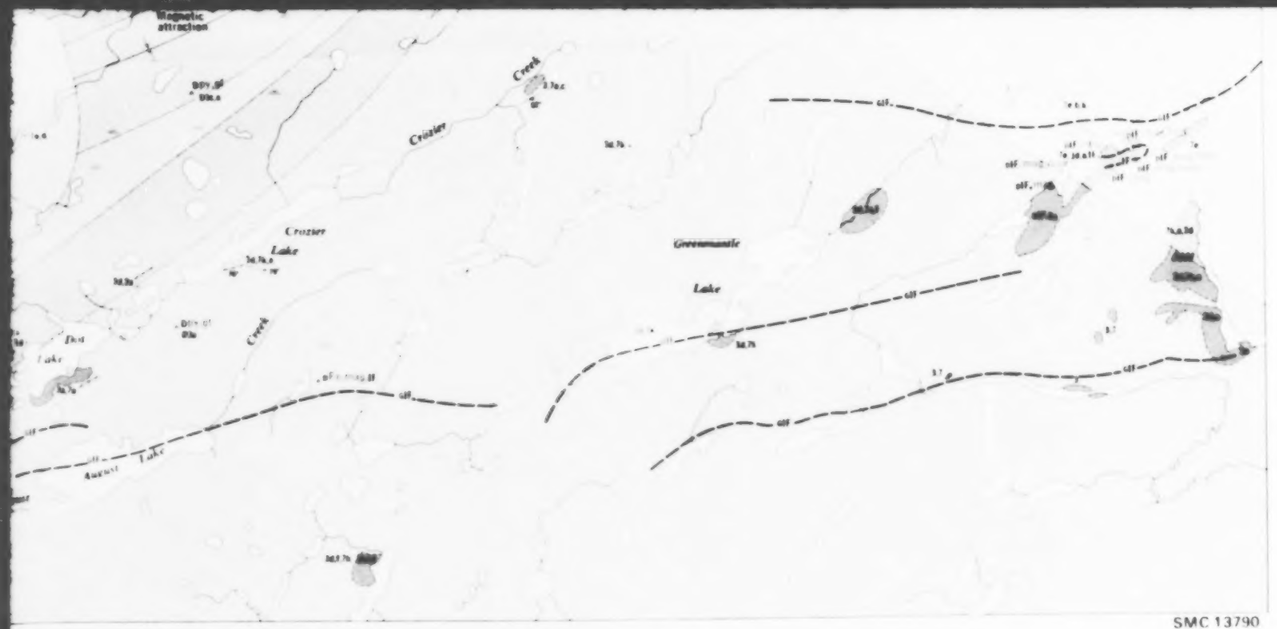
SYMBOLS

Geological strike
Inferred bedrock outcrop
Area of bedrock outcrop
Bedding, top unknown, inclined, vertical
Lava flow, top (arrow) from pillow shape and banding
Schistosity, (homogeneity, inclined, vertical)
Foliation (horizontal, inclined, vertical)
Lineation with plunge
Geological boundary, position interpreted
Geological boundary, obscured from view

Scale 1 125 00

1 0 1 2 1 4

Kilometres



SMC 13790

SYMBOLS

Scale 1 125 000

Kilometres

PAST PRODUCING MINES

Pickle Crow Explorations Limited (formerly Pickle Crow Gold Mines Ltd.) A1

Central Patricia Gold Mines Ltd. A2

All past producers, regardless of the value of metals produced, are listed and indicated separately on the map.

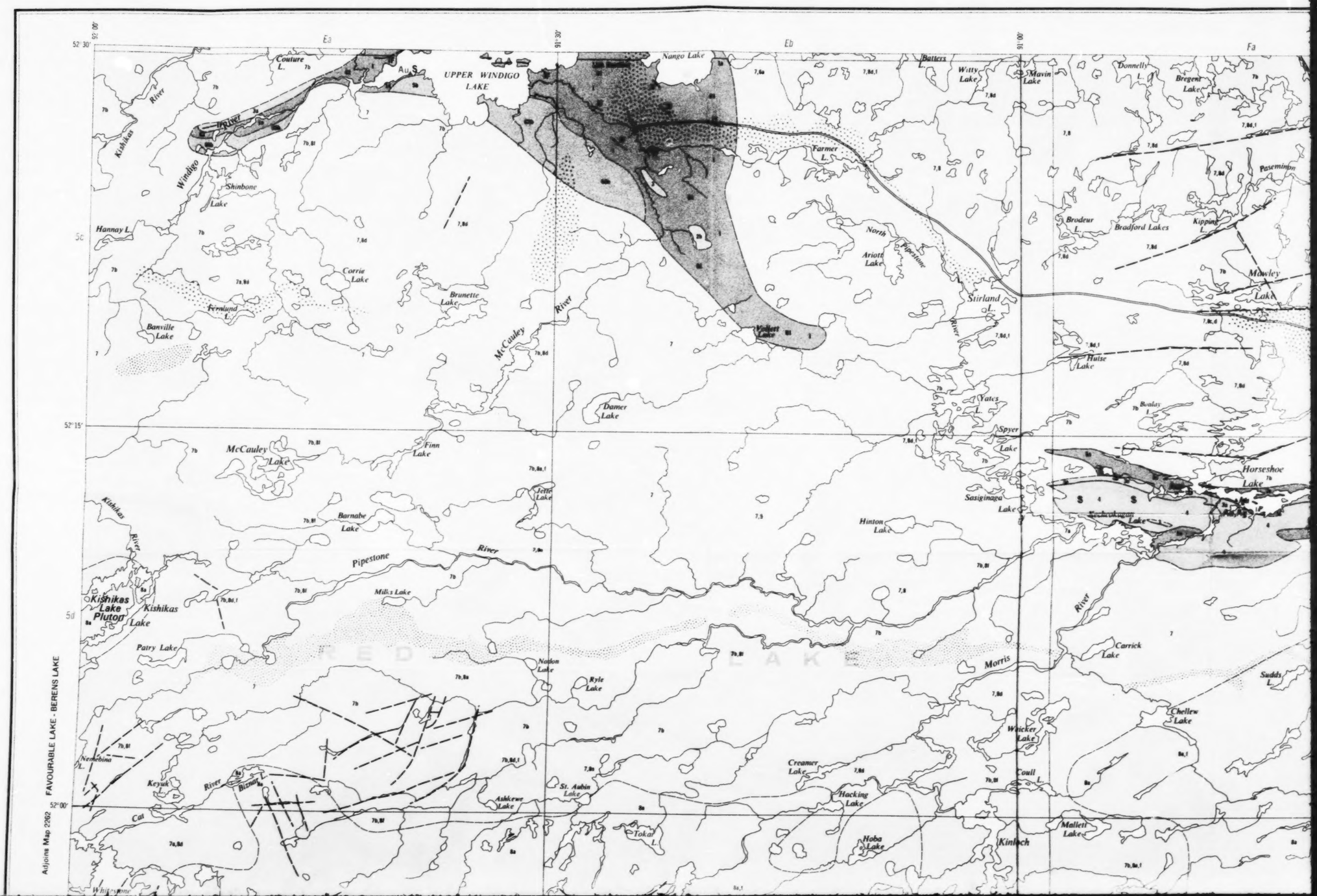
THE MAP INDEX

The red letters and numbers in the borders provide a location reference system based on that of Map 2310, Ontario Mineral Map, 1974.

HOW TO OBTAIN ADDITIONAL INFORMATION

Four uncoloured preliminary maps covering this sheet can be obtained from the Publications Office, Division of Mines, Ministry of Natural Resources, Toronto. These are at a scale of one inch equals two miles and are named as follows: P.806 Upper Windigo Lake—Horseshoe Lake Sheet, P.807 Forester Lake—Wigwascence Lake Sheet, P.808 Bamaji Lake—Lake St. Joseph Sheet, P.809 Achapi Lake—Mischkow River Sheet.

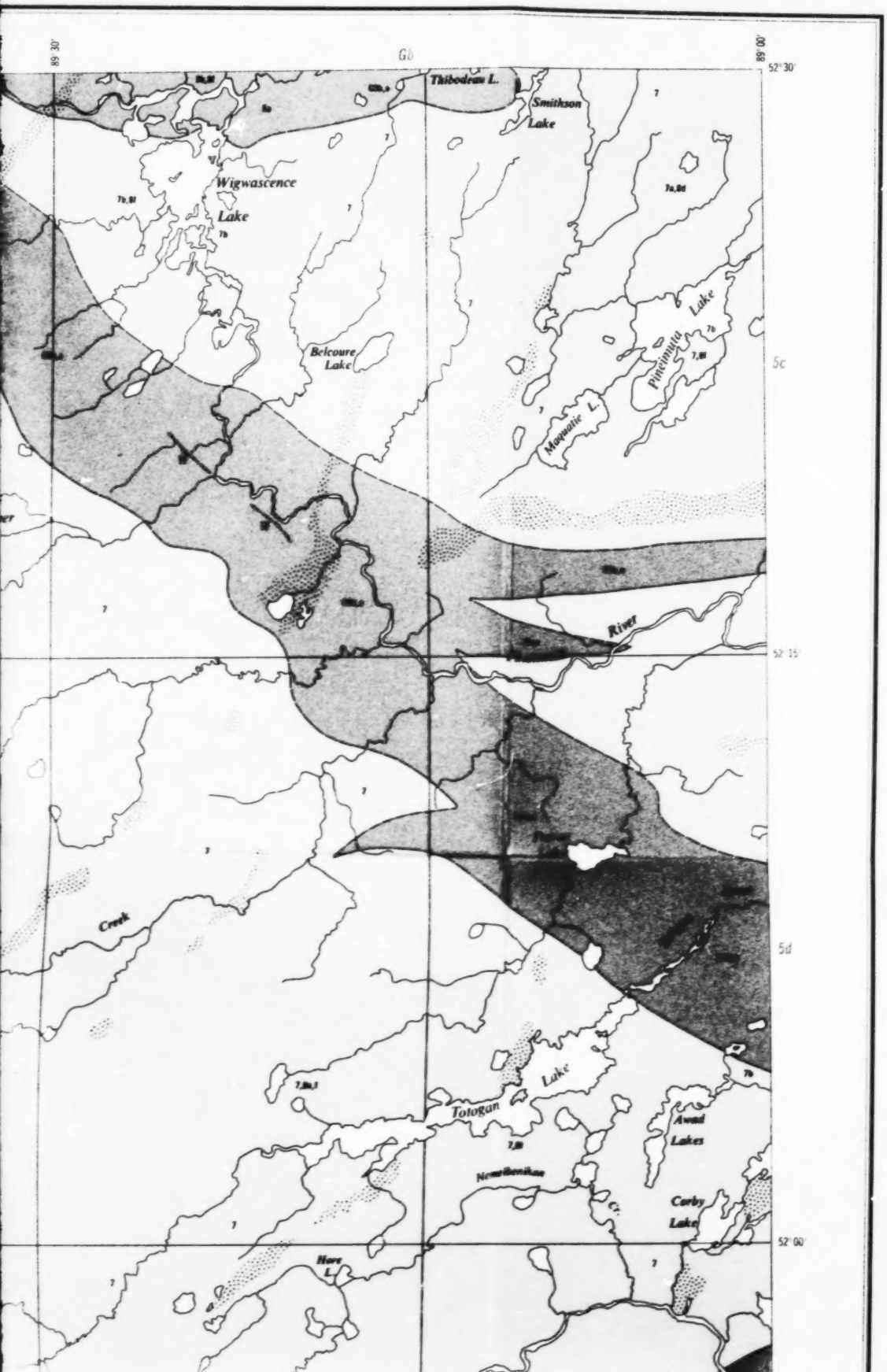
Published geological maps covering this sheet are indicated on index Maps 2082, 2083, and 2084 of the Division of Mines, Ministry of Natural Resources, Toronto, and on index Sheets 52 and 53 of



ONTARIO
DIVISION OF MINES
HONOURABLE LEO BERNIER, *Minister of Natural Resources*
DR J. K. REYNOLDS, *Deputy Minister of Natural Resources*
G. A. Jewett, *Executive Director, Division of Mines* E. G. Pye, *Director, Geological Branch*

Adjoins Map 2292 BIG TROUT LAKE - NORTH CARIBOU LAKE

Map 2218
Cat Lake—Pickle Lake
Geological Compilation Series



Scale, 1 inch to 200 miles

N.T.S. reference 53A, 53B, 52O, 52P.

LEGEND

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Till, clay, sand, gravel.

UNCONFORMITY

PRECAMBRIAN

LATE PRECAMBRIAN

10 Diabase dikes (Keweenawan)[a]

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)

MAFIC INTRUSIVE ROCKS

9 Diorite, gabbro anorthosite, gabbroic anorthosite.

INTRUSIVE CONTACT

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

SYNTECTONIC TO LATE TECTONIC GRANITIC PLUTONS[b]

8 Unsubdivided.
8a Massive, equigranular to porphyritic, quartz monzonite to granodiorite.[c]
8b Massive biotite-hornblende monzonite to syenodiorite.
8c Massive biotite-hornblende quartz diorite to diorite.
8d Massive, equigranular biotite, biotite-hornblende, hornblende-biotite trondhjemite.
8e Pegmatite, aplite.
8f Mylonitic, biotite and hornblende-biotite trondhjemite to granodiorite.

INTRUSIVE CONTACT

EARLY TO SYNTECTONIC GRANITIC PLUTONS[d]

7 Unsubdivided.
7a Migmatite predominantely orthogneiss.
7b Foliated to gneissic biotite and hornblende biotite trondhjemite to granodiorite.
7c Diorite, quartz diorite.

INTRUSIVE CONTACT

Resources, Ottawa.

Published geological reports covering this sheet are listed in Bulletin 25 and its supplement of the Division of Mines, Ministry of Natural Resources, and in Index of Publications, Geological Survey of Canada, 1961, 1970.

Topographic maps of the area can be obtained from the Ministry of Natural Resources, Toronto, or the Topographic Survey, Department of Energy, Mines and Resources, Ottawa.

Air photographs can be obtained from the Air Photo Library, Ministry of Natural Resources, Toronto, or from the National Air Photographic Library, Department of Energy, Mines and Resources, Ottawa.

Aeromagnetic maps covering this sheet can be obtained from Publications Office, Ontario Division of Mines or the Geological Survey of Canada.

The name and ownership of several mineral occurrences in the Pickle Lake area are given on Map 2310, Ontario Mineral Map, 1974.

Information on geology, mines, and mineral occurrences can be obtained at the offices of the Resident Geologist at Red Lake and Sioux Lookout.

Mining claim maps and general information can be obtained at the office of the Mining Recorder at Red Lake, or at the Ministry of Natural Resources, Toronto.

Up-to-date information on current developments of the mineral industry can be obtained from the Annual Report of the Resident Geologist at Red Lake, published in the early months of each year.

MINERAL PRODUCTION AND RESOURCES

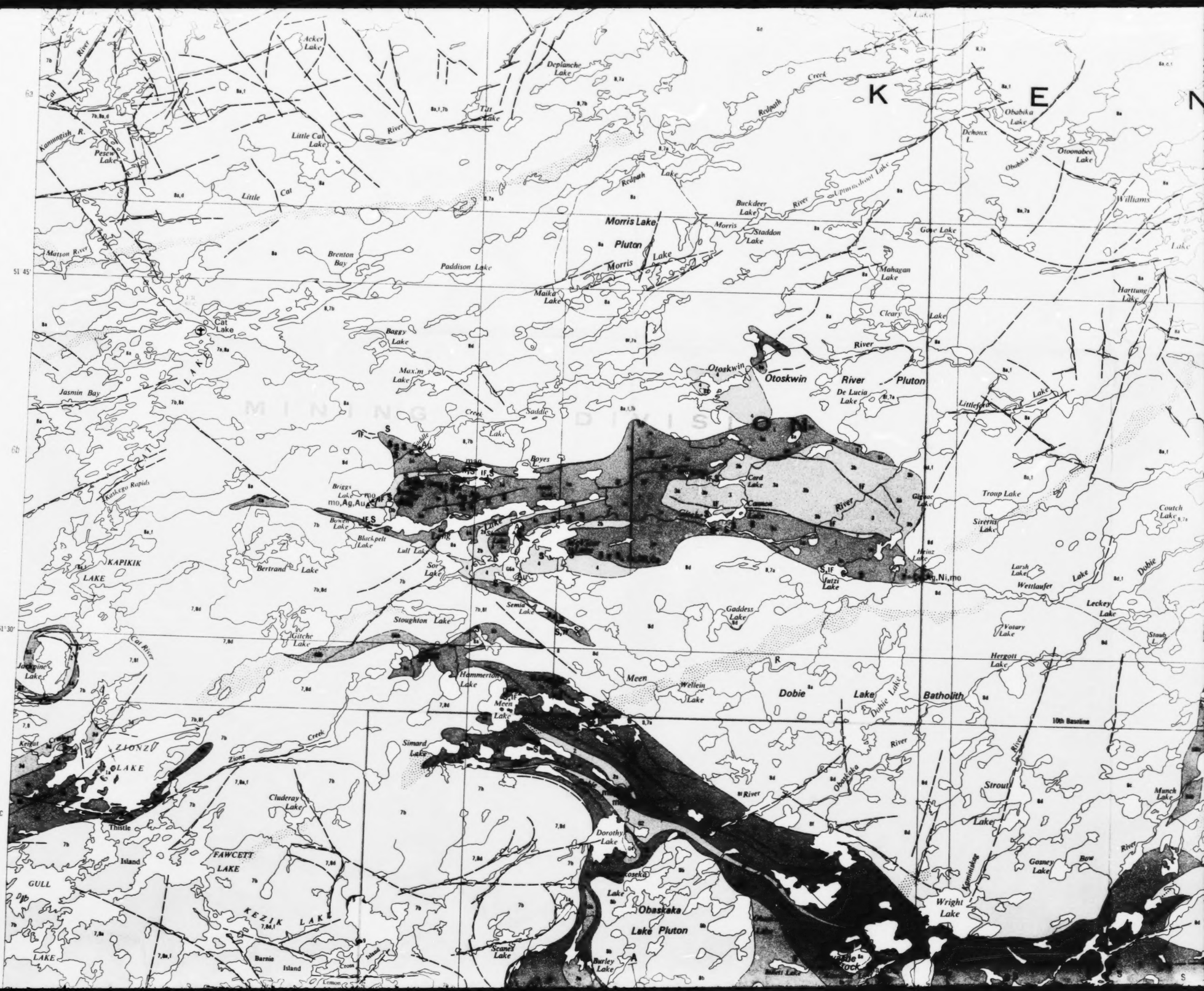
Gold was discovered in the immediate area of Pickle Lake in the late twenties. The operations of Central Patricia Gold Mines Ltd. and Pickle Crow Gold Mines Ltd. have a cumulative production of 2,081,178 ounces of gold (Mineral Deposit Files, GeoScience data center, Ontario Division of Mines). Active gold mining in the Pickle Lake area ceased with the closure of the Pickle Crow Mines in 1966.

Union Miniere Exploration and Mining Corp. Ltd. is presently developing a copper nickel deposit estimated to contain 10,000,000 tons of 1.6% copper and 0.2% nickel approximately 7 miles west of Pickle Lake (Canadian Mines Handbook 1972-73, p. 330).

On the south shore of Lake St. Joseph, Steerola Exploration Co. a wholly owned subsidiary of Steep Rock Iron Mines Ltd. has outlined a deposit of 650,000,000 tones of magnetite bearing taconite (Canadian Mines Handbook 1972-73 p. 309).

Within the project area the metavolcanic-metasedimentary belts contain numerous showings of gold, base metals, sulphides and, iron. Exploration for economic mineral deposits over the past 40 years has been intensive. Currently, and in the recent past, the International Nickel Co. of Canada Ltd., Selco Mining Corp. Ltd., Cochenour Willans Gold Mines Ltd., and Union Miniere Explorations and Mining Corp. Ltd. have all conducted extensive exploration programs to evaluate the mineral potential of the area.

The metavolcanic-metasedimentary belts are considered highly favourable to economic mineral deposits.



N O R A

11th Baseline

Endospruce Lakes

McGimsie Lake

Willmet Lake

Obustigue Lake

Kiniwabik Lake

Kiniwabik Creek

Mamiegowish Lake

Mamiegowish River

Greenlee Lake

Muskwasee Lake

Muskwasee Creek

Foxhead Creek

Foxhead Lake

Toner Lake

Williams Lake

Harttung Lake

Lynxhead Rapids

Collis Lake

Otoskwin River

Otoskwin Lake

Long Current Rapids

Froats Lake

Shinagmabin Creek

Shinagmabin Lake

Ard. Lake

Engler Lake

Bow Lake

Tarp Creek

Tarp Lake

Vernham Lake

Destuane Lake

Robinet Lake

Wyvill Lake

Deepwater Rapids

Shoal Rock Rapids

Steep Rock Rapids

Nanos Lake

Nanos River

Dobie Lake

Northmore Lake

Musser Lakes

Kibler L.

Pinsford Lake

Trebell Lake

Sayres Lake

Horvath Lake

Leckey Lake

Stouk L.

Tranter Lake

Massia Lake

Dobie Batholith

Bow Creek

Minominatik Lake

Minominatik River

Munch Lake

Kawingwana River

Bough Lake

Skeba Lake

Wimbabika Lake

Ochig Lake

Ochig Fault

Ochig Lake Fault

Pluton

Little Ochig Lake

Jean Lake

Pickle Lake

Pickle Creek

Pickle Crow

Pickle Crow Pit

Central Pickle Lake

PONSFORD

Stock

Hooker

Burkoski

Au

Cu, Ni

mag

CONNELL

McCULLAGH

McCullagh Cr.

Kapichi Lake

Kapichi River

Quoin Lake

Ruby Lake

Ruby Creek

Ruby Pluton

Badesdensi Lake

Badesdensi Creek

Collishaw Lake

Collishaw Creek

Driver Lake

Buckshewa Creek

Pikanogan L.

Pikanogan Creek

Tallabora Lake

Tallabora Creek

Skeega River

Lake 1091'

Shoal Lake

Cawston Lakes

Nemeibenikan Lake

Jacobson L.

Lauber Lake

Lauber River

Jervis Bay

Jervis Bay Lake

Algoire Lake

Otoskwin

Kakagiwizida L.

Ozhuskans Rapids

Mazaner L.

Skwa Lakes

Monmonawson Lake

Quill L.

Tar Lake

Foaming Creek

Dunkirk Lake

Bowern Lake

Odlum Creek

Odlum Lake

Trading

Devos Lake

Devos Pluton

Juniper Lake

Cirerar Lake

Pasquino Lakes

First

Loon Lake

Enright

Crosshaw Lake

Bye Lake

Napier Lake

Smag

Townshend Lake

Martinsen Lake

Coulas Lake

Etowamami

Dugal Lake

Dean Lake

Serveni Lake

Penhale Lake

Eckford L.

Rouble Lake

Weiberg Lake

Veale L.

Seach Lake

Harney

Rorabeck Lake

Pruner Lake

Farrer Lake

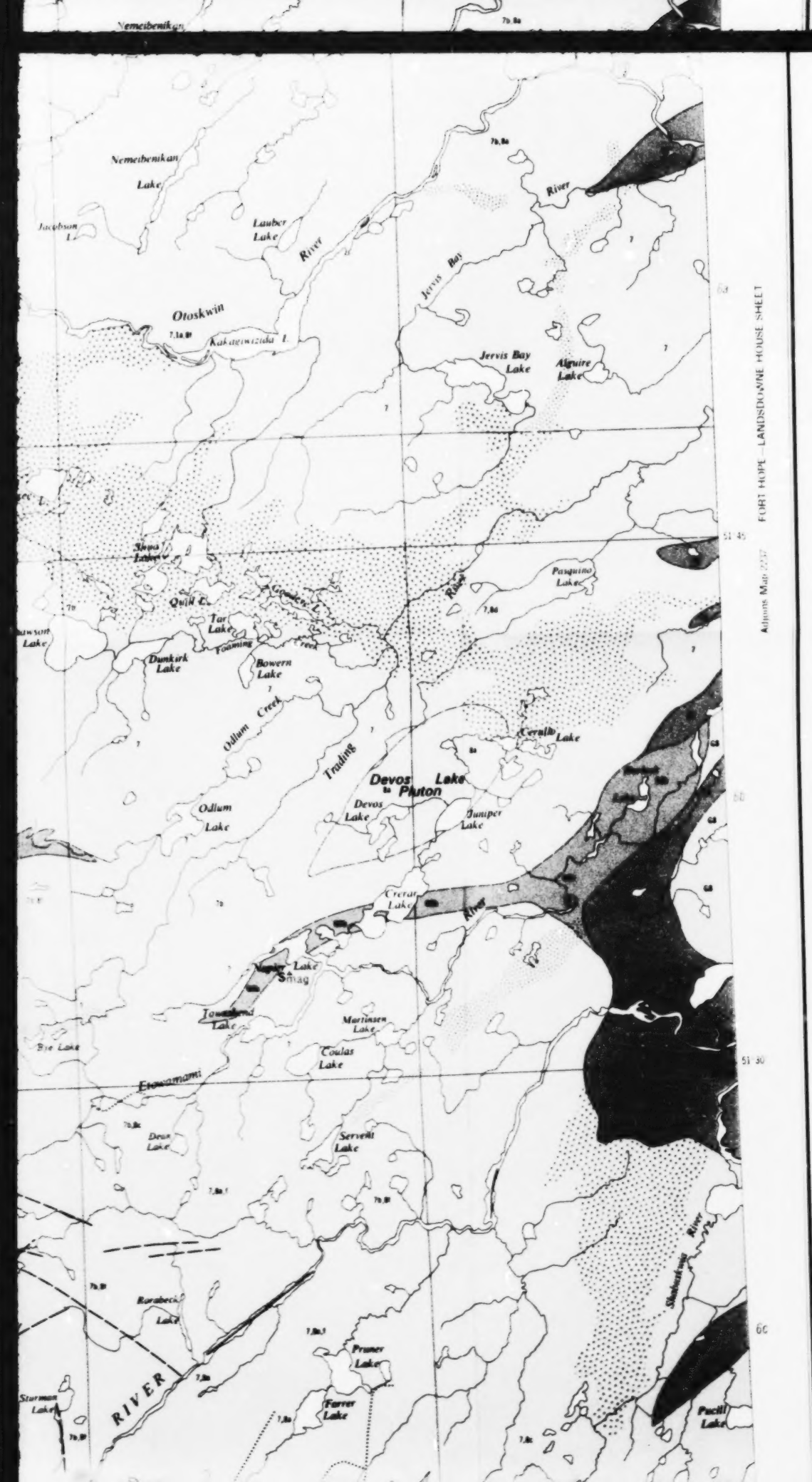
Quarrier Lake

Sturman Lake

Warren Lake

RIVER

MINING DIVISION



INTRUSIVE CONTACT

PRETECTONIC GRANITIC PLUTONS[e]

6 — 6a Quartz and/or feldspar porphyry.
6b Trondhjemite to quartz monzonite (Bamaji Lake Complex).

MIGMATITE

5 — 5 Unsubdivided.
5a Biotite-quartz-feldspar gneiss (metasedimentary migmatite).
5b Hornblende-feldspar-quartz gneiss (metavolcanic migmatite).

INTRUSIVE CONTACT

MAFIC TO INTERMEDIATE INTRUSIVE ROCKS[e]

4 — 4 Gabbro, diorite, anorthosite, anorthositic gabbro.

INTRUSIVE CONTACT

METAVOLCANICS AND METASEDIMENTS[f]

METASEDIMENTS[g]

3 — 3 Unsubdivided.
3a Conglomerate.
3b Greywacke, quartzite, siltstone.
3c Slate, argillite.
3d Biotite-quartz-plagioclase schist and gneiss ± hornblende ± sericite ± garnet and associated migmatite.

FELSIC TO INTERMEDIATE METAVOLCANICS

2 — 2 Unsubdivided.
2a Massive, dacite to rhyolite flows.
2b Pyroclastic breccias, agglomerate and tuff with some massive porphyritic flow rocks.

MAFIC TO INTERMEDIATE METAVOLCANICS

1 — 1 Unsubdivided.
1a Massive to foliated basalt to andesite flows.
1b Pillowed flows.

IF — Iron formation[h]

S — Sulphide mineralization

[e] Precise age uncertain.

[b] Precise age uncertain. This refers to syntectonic to late tectonic massive to weakly foliated granitic plutonic complexes such as Granitebois Lake Stock.

[c] In general this refers to the massive, equigranular to porphyritic granodiorite to quartz monzonite bodies which intrude the earlier, less potassic, commonly metamorphosed and sheared, trondhjemitic and migmatitic rocks.

[d] In general, this refers to early tectonic to syntectonic, foliated to gneissic, locally sheared trondhjemite, quartz diorite, and granodiorite rocks that enclose the more massive, more potassic composite batholithic intrusive bodies. These rocks are commonly migmatitic and metamorphosed.

[e] Generally subvolcanic intrusions.

[f] Rocks in these groups are subdivided lithologically and the order does not imply age relationships within or among the groups.

[g] In the Lake St. Joseph area, metasediments commonly contain abundant porphyroblasts of staurolite and/or andalusite. Locally sillimanite bearing rocks are also present. Some of the metasediments north of Forester Lake are cordierite bearing rocks.

[h] Iron formation (associated with formations of stratigraphic units 1, 2, and 3.).

The letter 'G' preceding a rock unit number, for example "G5b", indicates interpretation from geophysical data in drift covered or unmapped areas.

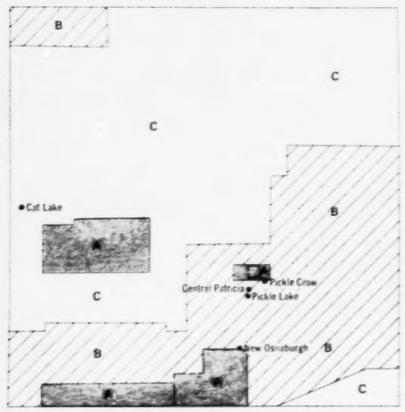
The letter 'D' preceding a rock unit number, for example "D3c", indicates identification from diamond drill core.

SYMBOLS

Esker.

Recessional moraine.

GEOLOGICAL RELIABILITY DIAGRAM

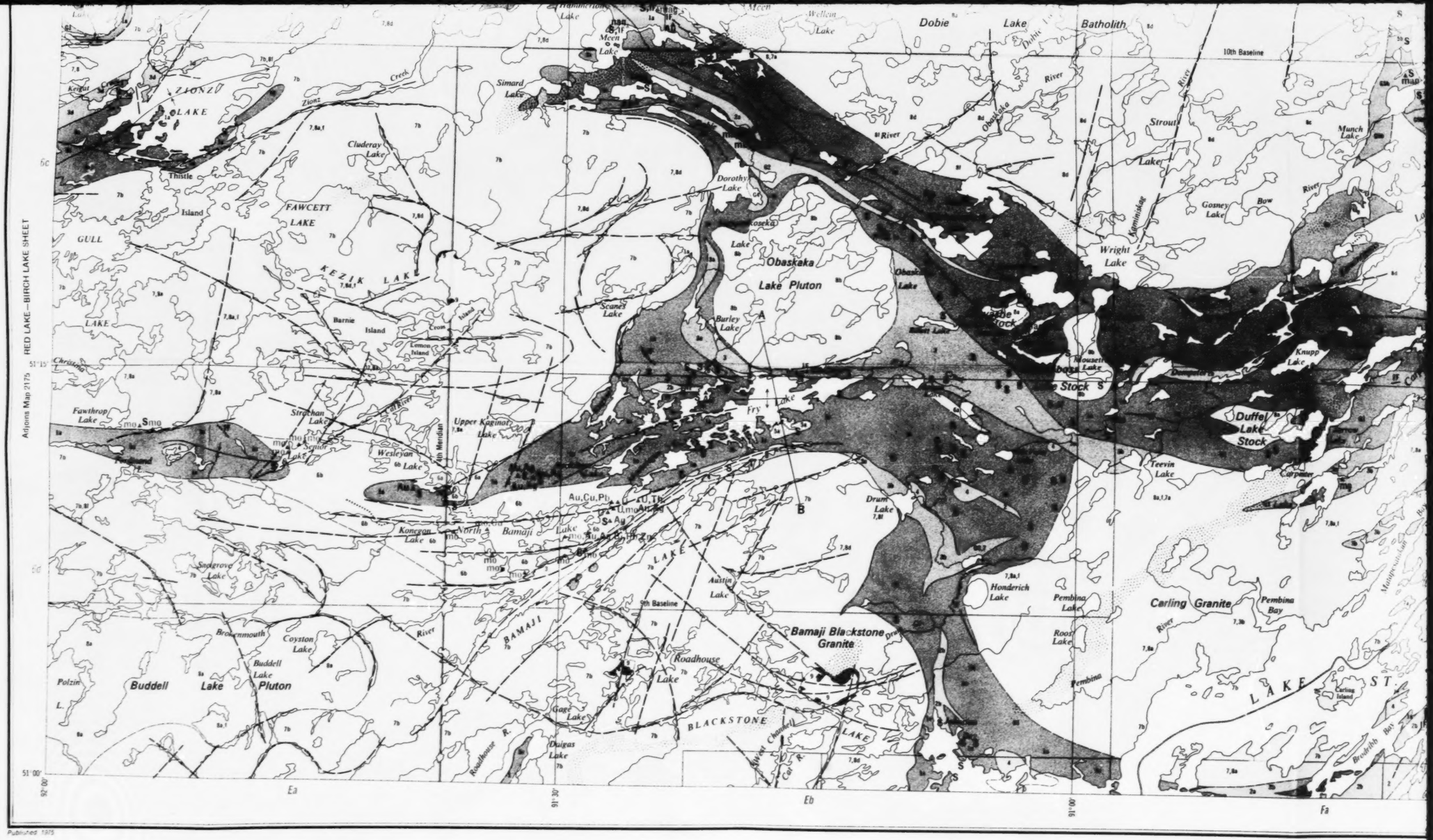


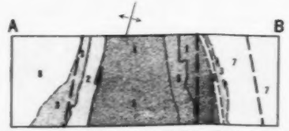
A Detailed mapping, 1" to 1000', 1" to ¼ mile; 1 inch to ⅜ mile.

B Semi-reconnaissance mapping, 1" to 1 mile; 1" to 2 miles.

C Unmapped or 1" to 4 mile mapping.

Published 1975





SECTION - BAMAJI LAKE - FRY LAKE

CA

G

KENO

Miles 2 1 0 2

Metres 5000 0

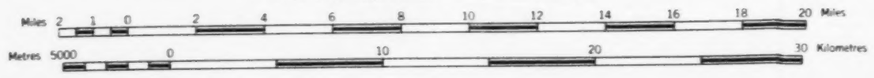
Map 2218

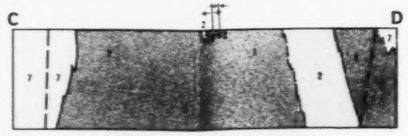
CAT LAKE–PICKLE LAKE

Geological Compilation Series

KENORA AND THUNDER BAY DISTRICTS

Scale 1:253,440 or 1 Inch to 4 Miles





SECTION - PICKLE CROW

MAP

Geology by ... assistants, O...

Geological co... assistants, 19...

Geology from ... Division of M... unpublished ... and interpret... photographs.

Records of ... Geologist's o... Library, Toro...

Cartography ... and Mapping

Map base co... of the Nation... information b...

Lambert Conformal Projection, Standard Parallels 44°30' and 53°30'

h Iron formation (associated with formations of stratigraphic units 1, 2, and 3.).

The letter 'G' preceding a rock unit number, for example "G5b", indicates interpretation from geophysical data in drift covered or unmapped areas.

The letter 'D' preceding a rock unit number, for example "D3c", indicates identification from diamond drill core.

SYMBOLS

- Esker.
- Recessional moraine.
- Geological boundary.
- Synclinal axis.
- Anticlinal axis.
- Fault.
- Lineament.
- 1091' — Altitude in feet above mean sea level.
- Provincial highway
- Other road.
- Winter road.
- Aircraft landing facilities.
- Small community.
- Past producing mine.
- Mineral occurrence.
- Mining division with boundary.
- District boundary.
- Township boundary, meridian or base line.
- Township boundary, unsurveyed.
- A — B — Line of section.

MAP COMPILATION SOURCES

Geology by R. P. Sage, F. W. Breaks, W. Troup and assistants, Operation Pickle Lake, 1972.

Geological compilation by R. P. Sage, F. W. Breaks and assistants, 1972.

Geology from published and unpublished maps of the Division of Mines, and Geological Survey of Canada, unpublished maps and reports of mining companies, and interpretation of aeromagnetic maps and aerial photographs.

Records of assessment work on file at Resident Geologist's office, Red Lake and Assessment Work Library, Toronto.

Cartography by M. G. Sefton and assistants, Surveys and Mapping Branch, 1974.

Map base compiled from sheets 53A, 53B, 52O, 52P of the National Topographic System, with additional information by R. P. Sage, F. Breaks and assistants.

METAL AND MINERAL REFERENCE

Ag . . . . . Silver	Ni . . . . . Nickel
Au . . . . . Gold	Pb . . . . . Lead
Bi . . . . . Bismuth	Pd . . . . . Palladium
Co . . . . . Cobalt	Pt . . . . . Platinum
Cu . . . . . Copper	Th . . . . . Thorium
Fe . . . . . Iron	U . . . . . Uranium
mag . . . Magnetite	Zn . . . . . Zinc
mo . . . . Molybdenite	

APPENDIX A – MAJOR AND TRACE ELEMENT ANALYSES AND NORMS OF WHOLE ROCK SAMPLES, CAT LAKE – PICKLE LAKE AREA.

	BAMAJI-FRY LAKES BELT								BAMAJI-FRY LAKES BELT (WEST)		JOHNSTON BAY– FRY LAKE BELT			MEEN–DEMPSTER LAKES BELT																		
Oxide [1,2]	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AJ
SiO_2	45.9	46.0	60.7	49.7	52.7	63.3	67.7	68.1	67.2	70.6	55.5	50.6	69.0	53.8	71.8	65.6	73.0	73.8	68.9	73.0	48.1	71.3	65.5	71.2	41.6	51.4	45.8	53.0	54.2	66.8	64.8	68.6	74.6
Al_2O_3	15.3	15.3	15.9	13.3	17.0	16.5	17.7	16.8	17.1	15.7	19.6	13.0	15.5	14.2	16.9	18.8	14.8	16.3	15.1	16.0	15.8	14.5	17.0	15.0	3.34	10.3	17.0	14.7	16.6	13.7	16.2	15.8	15.5
Fe_2O_3	2.43	3.95	0.99	2.90	2.10	1.80	0.74	1.44	1.72	0.42	1.47	4.95	0.74	1.66	0.27	0.75	0.43	.12	1.19	0.54	2.85	0.59	0.42	1.16	7.20	1.82	1.60	2.84	2.63	0.76	0.71	1.64	0.41
FeO	8.88	9.32	3.39	11.4	6.20	1.73	1.58	1.64	1.40	1.15	3.91	10.3	2.66	8.57	0.74	1.03	0.96	.30	1.92	0.74	7.60	2.21	3.02	0.66	9.53	8.71	7.45	5.16	7.53	1.40	2.80	0.81	0.77
MgO	10.4	7.03	3.00	7.79	5.40	1.98	1.45	1.95	1.52	0.60	2.61	4.32	1.99	6.80	0.16	1.20	0.12	0.00	2.17	0.27	7.80	1.50	1.32	0.28	26.0	10.4	11.2	7.79	3.80	0.71	1.19	0.10	0.93
CaO	10.6	10.6	5.94	7.47	6.78	4.99	3.57	4.24	2.86	2.07	8.79	8.19	2.29	10.7	1.65	4.30	2.80	1.50	1.83	1.65	11.6	6.76	2.34	2.18	2.69	10.8	10.9	10.5	6.29	4.40	3.51	2.17	0.95
Na_2O	0.84	1.75	4.13	2.81	3.78	4.13	3.67	3.08	4.15	4.58	5.64	3.48	4.40	2.02	6.20	4.62	0.62	6.25	2.80	5.66	1.65	0.40	7.13	4.23	0.27	2.21	1.27	3.34	4.91	3.96	4.55	5.80	4.31
K_2O	0.24	0.10	1.45	0.10	0.02	1.54	1.79	2.02	2.27	2.17	0.22	0.43	1.78	0.29	1.42	0.87	4.32	1.09	2.41	1.69	0.10	0.10	0.72	2.07	0.02	0.22	0.17	0.12	1.23	1.52	1.06	0.87	2.08
H_2O^+	3.82	2.71	1.05	3.02	3.22	1.04	0.80	ND.	0.92	0.86	0.72	1.06	1.04	1.18	0.90	1.17	1.22	0.75	1.92	0.62	3.03	1.40	1.44	0.81	8.50	1.89	3.27	1.55	1.14	1.19	1.47	1.56	0.83
H_2O^-	0.04	0.12	0.05	0.12	0.08	0.16	0.11	ND.	0.10	0.12	0.03	0.02	0.01	0.05	0.02	0.13	0.03	0.05	0.06	0.11	0.08	0.09	0.14	0.17	0.19	0.11	0.11	0.09	0.24	0.14	0.15	0.11	0.10
CO_2	0.15	0.18	3.23	0.15	1.95	2.91	0.38	ND.	0.18	0.42	0.22	0.15	0.12	0.10	0.12	0.10	0.18	0.10	0.12	0.22	0.18	0.20	1.38	1.47	0.23	0.21	0.20	0.18	0.08	4.30	4.16	1.23	0.16
TiO_2	0.53	1.11	0.48	1.31	0.92	0.45	0.30	0.36	0.41	0.24	1.04	1.90	0.38	0.81	0.57	0.62	0.10	0.44	0.43	0.15	0.75	0.30	0.51	0.26	0.40	0.54	0.17	0.71	1.03	0.30	0.59	0.46	0.06
P_2O_5	0.03	0.09	0.20	0.10	0.20	0.14	0.10	0.10	0.14	0.07	0.02	0.18	0.09	0.08	0.18	0.17	0.08	0.12	0.15	0.05	0.08	0.09	0.15	0.11	0.05	0.05	0.05	0.06	0.09	0.13	0.23	0.19	0.02
S	0.04	0.28	0.03	0.05	0.02	0.01	0.07	0.16	0.05	0.01	0.01	0.06	0.02	0.08	0.01	0.06	0.05	0.04	0.02	0.02	0.03	0.10	0.17	0.19	0.12	0.02	0.02	0.18	0.05	0.02	0.01	0.03	0.02
MnO	0.20	0.21	0.10	0.22	0.25	0.08	0.04	0.05	0.04	0.08	0.16	0.24	0.06	0.23	0.03	0.03	0.06	0.01	0.17	0.03	0.20	0.06	0.07	0.03	0.31	0.21	0.20	0.17	0.30	0.06	0.06	0.06	0.05
Total	99.4	98.8	100.6	100.4	100.6	100.8	99.9	102.0	100.1	99.1	99.9	98.9	100.1	100.6	101.0	99.4	98.0	100.9	99.2	100.8	99.8	99.6	101.3	99.8	100.4	98.9	99.6	100.4	100.1	99.4	101.5	99.4	100.8
Specific Gravity	3.04	3.04	2.70	2.98	2.84	2.72	2.72	ND.	2.71	2.68	2.86	3.05	2.70	3.02	2.66	2.67	2.68	2.63	2.72	2.65	3.05	2.76	2.68	2.66	2.77	3.00	2.93	2.97	2.84	2.72	2.74	2.66	2.67

Trace Element [1,4]

Ag	-	-	-	-	-	-	-		-	-	-	1	1	2	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	2
As	3	3	3	3	3	3	3		3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ba	-	-	500	-	-	200	450		500	400	-	150	390	90	410	280	330	140	400	380	80	100	250	850	70	100	90	110	680	390	400	310	400
Be	-	-	-	-	-	-	-		-	-	-	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Co	60	50	20	55	40	20	15		10	5	25	55	15	40	5	20	5	5	20	6	45	10	20	6	180	70	55	40	50	7	10	8	5
Cr	250	100	100	50	250	70	-		-	-	400	10	90	350	10	10	10	10	10	10	400	20	15	10	45	210	550	400	85	15	60	50	10
Cu	40	140	30	160	90	9	20		15	9	7	190	20	85	5	35	6	5	45	15	90	40	160	10	560	50	40	90	160	20	10	40	5
Ga	20	25	25	25	25	25	30		30	30	25	15	15	15	15	15	15	10	20	15	15	15	15	15	10	10	15	15	20	15	15	15	25
Li	-	-	-	-	-	-	30		50	30	-	30	20	8	9	25	20	5	10	10	10	10	15	10	4	15	25	8	20	10	20	15	20
Mo	-	-	-	-	-	-	-		-	-	-	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Ni	320	70	60	45	120	40	8		10	5	130	65	90	100	70	55	5	5	100	8	180	10	20	7	1280	280	340	140	70	10	30	20	5
Pb	-	-	20	-	-	-	30		20	20	-	10	10	10	10	10	10	10	15	10	10	10	10	10	10	20	10	10	10	10	10	10	20
Sb	1	1	1	1	1	1	1		1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sc	50	70	20	100	70	20	-		-	-	30	20	20	40	20	20	20	20	20	20	30	20	20	20	20	30	25	35	35	20	20	20	20
Sn	-	-	-	-	-	-	-		-	-	-	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Sr	130	200	1500	200	600	700	700		700	500	70	300	200	150	300	400	200	300	200	300	200	100	300	200	10	300	150	200	150	400	500	300	100
V	50	500	50	500	250	100	30		40	20	300	260	35	250	75	60	10	60	45	15	220	30	70	20	60	170	160	240	300	70	50	35	10
Y	-	20	-	20	20	-	-		-	-	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	25	20	20	25	20	20	20	20
Zn	95	120	75	100	120	50	55		70	65	35	140	55	90	15	65	55	15	40	35	85	55	130	35	150	110	65	65	140	40	60	40	30
Zr	30	100	200	150	150	100	100		100	100	100	170	80	60	140	150	130	150	180	60	60	90	120	90	50	50	60	50	90	120	130	100	30

Normative Mineral [5]

Apatite	.065	.199	.432	.218	.437	.303	.213	.213	.296	.150	.042	.396	.191	.171	.373	.361	.178	.249	.327	.104	.175	.200	.313	.238	.111	.108	.108	.126	.191	.292	.504	.411	.042
Pyrrhotite	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.219	.070	.283	.034	.211	.184	.138	.072	.069	.109	.369	.587	.681	.441	.072	0.71	.628	.176	.075	.036	.108	.000
Ilmenite	0.76	1.63	0.69	1.90	1.34	0.65	0.42	0.51	0.58	0.34	1.44	2.780	.535	1.150	.786	.876	.148	.338	.625	.208	1.090	.444	.707	.374	.589	.777	.659	.994	1.45	.449	.860	.663	0.84
Orthoclase	1.47	.63	8.87	.62	.12	9.42	10.80	12.10	13.60	13.10	1.30	2.67	10.60	1.75	8.32	5.22	27.10	6.39	14.90	9.96	0.62	.628	4.24	12.60	0.12	1.34	1.03	0.74	7.36	9.66	6.56	5.20	12.40
Albite	7.8	16.6	38.3	26.2	35.4	38.3	33.4	27.9	37.7	42.0	50.4	32.8	40.0	18.5	55.1	42.1	5.9	55.6	26.2	50.6	15.4	3.8	63.7	39.2	2.6	20.5	11.7	30.1	44.6	38.2	42.7	53.8	38.9
Anorthite	40.2	35.5	21.2	24.3	30.6	22.6	17.4	20.6	13.4	10.0	27.4	19.5	10.9	29.3	6.9	20.5	14.2	6.6	8.4	7.8	36.9	35.0	10.6	10.4	8.3	18.1	41.3	24.9	19.8	16.2	16.6	9.8	4.6
Corundum	0.00	0.00	0.00	0.00	0.00	0.00	3.83	2.25	3.24	2.46	.00	.000	2.64	.000	2.81	3.16	4.87	2.60	5.60	2.15	.000	1.92	.65	2.37	.000	.000	.000	.000	.000	.000	1.98	2.09	4.89
Magnetite	2.19	2.68	1.07	3.05	2.29	1.94	0.78	1.52	1.82	0.45	1.53	3.74	0.78	1.77	0.28	0.80	0.47	.000	1.30	0.56	2.45	0.66	0.44	0.07	7.96	1.96	1.72	2.32	2.67	0.85	0.78	0.94	0.43
Hematite	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.083	.000	.000	.000	.000	.000	.786	.000	.000	.000	.000	.000	.000	.000	.557	.000
Wollastonite	0.00	0.00	3.16	5.45	1.26	0.81	0.00	0.00	0.00	0.00	6.38	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Enstatite	.000	.000	8.62	22.50	15.70	5.69	0.41	5.47	4.28	1.71	7.22	8.38	5.56	13.00	0.49	3.36	0.35	.000	6.25	0.74	16.30	4.40	3.63	0.80	44.80	19.20	14.20	13.10	7.42	0.56	3.44	.000	2.60
Ferrosilite	.000	.000	4.12	14.80	7.52	0.93	1.48	0.28	0.38	1.29	3.79	9.33	3.14	7.68	0.17	0.05	1.03	.000	1.84	0.54	7.74	2.49	3.18	.000	5.93	7.86	4.62	3.65	6.29	0.36	3.22	.000	0.87
Quartz	.000	.000	13.40	.71	5.21	19.20	27.40	28.30	24.60	28.30	0.57	2.51	25.60	6.80	24.70	23.40	45.60	27.90	34.50	27.20	0.99	50.00	11.90	32.40	.000	0.54	0.00	1.65	0.00	28.30	23.20	26.30	35.20
Diopside	8.85	9.42	.000	.000	.000	.000	.000	.000	.000	.000	.000	8.31	.000	12.20	.000	.000	.000	.000	.000	.000	12.20	.000	.000	.000	.000	20.90	8.42	17.0	4.82	3.08	.000	.000	.000
Hypersthene	3.20	6.42	.000	.000	.000	.000	.000	.000	.000	.000	.000	3.25	.000	7.18	.000	.000	.000	.000	.000	.000	5.78	.000	.000	.000	0.51	3.58	4.78	4.31	4.20	.000	.000	.000	.000

								PASHKOKOGAN LAKE – MISEHKOW RIVER BELT											LAKE ST. JOSEPH BELT (EAST)		HORSESHOE LAKE BELT					MISCELLANEOUS GRANITIC STOCKS AND BATHOLITHS							
AC	AD	AE	AF	AG	AH	AJ	AK	AL	AM	AN	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BJ	BK	BL	BM	BN
45.8	53.0	54.2	66.8	64.8	68.6	74.6	66.0	60.5	51.4	58.3	66.8	54.4	63.8	51.2	63.7	63.4	67.5	44.2	40.5	58.6	50.0	64.0	48.1	51.0	73.5	67.0	74.1	60.7	69.8	70.2	71.9	67.0	46.4	62.0
17.0	14.7	16.6	13.7	16.2	15.8	15.5	16.8	16.4	13.9	20.8	17.7	14.3	15.2	15.6	14.6	18.2	16.8	6.23	5.19	23.4	14.4	15.1	15.5	12.5	14.5	16.6	11.9	13.5	15.8	15.7	14.4	16.4	13.8	15.4
1.60	2.84	2.63	0.76	0.71	1.64	0.41	1.57	2.57	3.20	2.17	0.84	1.45	1.98	1.95	3.58	0.56	0.43	1.74	4.94	1.04	2.28	0.63	2.30	5.31	0.75	1.52	1.61	5.14	1.38	1.06	0.75	1.60	6.81	2.11
7.45	5.16	7.53	1.40	2.80	0.81	0.77	1.99	3.98	8.55	4.13	2.14	6.42	4.06	9.22	3.98	4.75	3.95	41.1	6.80	4.64	8.20	2.51	8.45	6.55	0.41	2.32	1.33	4.12	1.03	1.11	0.88	1.62	7.37	2.89
11.2	7.79	3.80	0.71	1.19	0.10	0.93	1.90	1.90	7.79	1.53	0.77	7.65	1.55	6.00	1.63	2.95	1.93	2.43	28.3	2.40	7.34	4.28	7.46	9.85	1.20	1.05	0.40	2.17	0.59	0.28	0.61	0.91	5.55	4.72
10.9	10.5	6.29	4.40	3.51	2.17	0.95	3.80	6.50	9.93	1.79	3.62	9.85	4.60	11.5	4.27	3.78	3.88	1.01	3.21	1.23	10.20	4.65	11.2	11.3	1.10	4.16	2.24	4.63	1.97	2.82	1.42	3.20	9.09	5.30
1.27	3.34	4.91	3.96	4.55	5.80	4.31	5.04	3.34	2.40	2.43	3.34	2.62	3.32	1.91	4.25	3.49	3.34	1.18	0.27	1.80	2.94	3.60	2.67	1.74	3.32	4.60	2.94	3.58	4.04	4.71	4.50	4.71	3.00	3.77
0.17	0.12	1.23	1.52	1.06	0.87	2.08	2.82	1.12	0.24	3.26	1.69	0.53	1.66	0.15	0.48	1.99	1.50	1.52	0.02	2.92	0.16	2.27	0.33	0.15	5.32	1.52	3.06	3.02	4.30	2.77	3.78	2.68	1.64	2.89
3.27	1.55	1.14	1.19	1.47	1.56	0.83	0.42	1.38	1.25	2.89	1.67	0.93	1.78	0.91	1.67	N.D.	N.D.	N.D.	8.25	1.86	1.38	1.22	1.00	0.91	0.47	0.48	0.32	0.49	0.42	0.51	0.28	0.45	.84	1.17
0.11	0.09	0.24	0.14	0.15	0.11	0.10	0.21	0.26	0.19	0.28	0.21	0.18	0.22	0.09	0.20	N.D.	N.D.	N.D.	0.23	0.11	0.12	0.14	0.14	0.07	0.18	0.22	0.27	0.26	0.27	0.13	0.13	0.18	.14	0.39
0.20	0.18	0.08	4.30	4.16	1.23	0.16	0.05	0.12	0.12	0.10	0.25	0.19	0.08	0.10	0.51	0.00	0.00	0.00	0.45	0.10	0.35	2.15	0.18	0.23	0.10	0.10	0.10	0.10	0.10	0.10	0.05	0.05	.11	0.15
0.17	0.71	1.03	0.30	0.59	0.46	0.06	0.45	0.80	0.98	0.82	0.61	0.56	1.06	1.01	1.06	0.58	0.45	0.22	0.28	0.91	0.07	0.44	1.24	0.64	0.11	0.52	0.67	1.82	0.37	0.29	0.19	0.47	3.07	0.59
0.05	0.06	0.09	0.13	0.23	0.19	0.02	0.20	0.28	0.09	0.16	0.14	0.17	0.38	0.09	0.40	0.17	0.12	0.23	0.03	0.15	0.05	0.15	0.10	0.06	0.05	0.18	0.26	0.66	0.14	0.10	0.07	0.22	1.67	0.12
0.02	0.18	0.05	0.02	0.01	0.03	0.02	0.00	0.01	0.02	0.02	0.04	0.02	0.01	0.11	0.06	0.20	0.10	0.10	0.08	0.01	0.13	0.08	0.15	0.07	0.00	0.02	0.01	0.10	0.00	0.00	0.00	0.00	.42	0.01
0.20	0.17	0.30	0.06	0.06	0.06	0.05	0.06	0.12	0.24	0.07	0.08	0.16	0.10	0.26	0.13	0.11	0.07	0.51	0.20	0.07	0.02	0.06	0.16	0.23	0.03	0.05	0.06	0.15	0.05	0.05	0.05	0.07	.16	0.09
99.6	100.4	100.1	99.4	101.5	99.4	100.8	101.3	99.3	100.3	98.8	99.9	99.4	99.8	100.1	100.7	98.0	100.0	100.0	98.7	99.2	98.4	101.3	99.0	100.6	101.0	100.3	99.30	100.6	100.3	99.8	99.0	99.6	100.1	101.6
2.93	2.97	2.84	2.72	2.74	2.66	2.67	N.D.	2.82	3.04	2.77	2.70	2.93	2.75	3.05	2.75	N.D.	N.D.	N.D.	2.84	2.73	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D	2.75
1	1	1	1	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	1	0	1	8	5	1	1	1	6	3	1	1	1	1	240	< 1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 3	< 3	< 3	0	3	3	3	3	4	0	0	0	0	0	0	0	0	3	0
90	110	680	390	400	310	400	890	320	110	780	610	270	350	90	240	600	400	400	50	300	150	600	150	150	440	320	750	780	700	570	430	620	1100	260
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	4	3	3	3	4	4	2
55	40	50	7	10	8	5	10	20	50	20	10	45	15	50	20	20	15	15	120	20	40	10	45	40	5	10	8	20	6	6	5	10	45	15
550	400	85	15	60	50	10	10	20	310	140	100	160	40	300	10	130	40	50	5700	100	750	70	440	70	10	10	10	10	10	30	10	25	45	160
40	90	160	20	10	40	5	10	15	50	30	25	70	10	25	15	20	20	15	30	25	140	20	100	390	5	25	15	20	20	5	8	7	60	15
15	15	20	15	15	15	25	20	20	15	20	20	15	15	15	15	20	20	10	5	20	20	20	25	15	15	15	15	20	15	15	20	20	20	9
25	8	20	10	20	15	20	30	20	10	60	15	15	20	9	8	40	30	50	4	100	9	10	10	6	30	15	25	40	15	20	55	45	6	15
10	10	10	10	10	10	10	10	10	40	10	10	10	10	10	10	10	10	< 10	10	0	10	10	10	10	10	10	10	10	10	10	10	10	10	< 1
340	140	70	10	30	20	5	30	30	120	60	35	15	15	150	25	30	25	20	1220	35	80	25	110	50	5	10	6	10	8	8	8	15	15	70
10	10	10	10	10	10	20	30	20	10	30	300	20	20	10	10	20	< 10	< 10	10	20	10	25	15	10	35	15	25	25	35	20	35	30	35	30
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	< 1	< 1	4	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0
25	35	35	20	20	20	20	20	20	35	20	20	20	20	40	20	20	20	20	20	20	55	20	50	75	20	20	20	20	20	20	20	20	30	10
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	10	10	10	10	10	10	10	10	10	10	10	10	10	< 1
150	200	150	400	500	300	100	1500	400	150	250	400	400	300	50	200	1200	500	250	10	1000	250	300	250	150	150	350	400	300	300	800	500	1200	1500	700
160	240	300	70	50	35	10	50	150	280	150	60	170	70	250	140	150	20	10	110	40	230	80	310	230	10	50	30	100	30	25	15	35	380	100
20	20	25	20	20	20	20	20	20	20	20	20	20	25	25	20	20	120	20	20	20	30	20	60	20	20	20	25	80	20	20	20	20	80	15
65	65	140	40	60	40	30	65	90	100	90	240	70	80	150	70	75	70	30	70	95	85	55	80	80	25	60	75	220	55	60	50	95	180	75
60	50	90	120	130	100	30	180	160	80	120	80	70	170	80	240	100	70	50	10	10	50	150	120	40	100	150	320	110	120	160	60	80	500	150
.108	.126	.191	.292	.504	.411	.042	.413	.610	.193	.355	.303	.362	.829	.193	.865	.356	.254	.545	.066		.108	.319	.215	.127	.105	.380	.566	1.416	.296	.211	.149	.466	3.612	0.279
0.71	.628	.176	.075	.036	.108	.000	.000	.036	.071	.074	.144	.071	.036	.392	.215	.000	.000	.000	.290		.467	.282	.534	.247	.000	.070	.036	.356	.000	.000	.000	.000	1.506	.000
.659	.994	1.45	.449	.860	.663	0.84	.618	1.16	1.40	1.21	0.88	0.79	1.54	1.44	1.52	0.81	0.63	0.35	0.41		1.01	0.62	1.77	0.90	0.15	0.73	0.97	2.68	0.52	0.41	0.27	0.66	4.42	1.12
1.03	0.74	7.36	9.66	6.56	5.20	12.40	16.40	6.89	1.45	20.40	10.30	3.19	10.20	0.91	2.93	11.80	9.09	10.00	0.12		0.98	13.60	2.00	0.90	31.50	9.06	18.80	18.30	25.60	16.50	22.70	16.00	10.02	17.12
11.7	30.1	44.6	38.2	42.7	53.8	38.9	44.6	31.2	22.0	23.1	31.0	23.9	31.1	17.6	41.3	31.4	30.3	11.9	2.53		27.3	32.8	24.6	15.8	29.8	41.6	27.4	32.9	36.6	42.7	41.0	42.7	27.8	31.9
41.3	24.9	19.8	16.2	16.6	9.8	4.6	14.7	27.5	27.0	8.3	17.6	26.1	21.2	34.4	19.0	17.7	18.6	3.9	13.4		26.5	18.6	30.1	26.2	5.1	19.6	9.8	12.1	8.9	13.5	6.7	14.6	20.0	16.6
.000	.000	.000	.000	1.98	2.09	4.89	.000	.000	.000	12.00	4.66	.000	0.56	.000	.000	4.18	3.17	1.64	.000		.000	.000	.000	.000	1.53	0.28	0.43	.000	1.38	0.07	0.54	0.51	.000	0.000
1.72	2.32	2.67	0.85	0.78	0.94	0.43	1.62	2.50	2.65	2.40	0.91	1.54	2.16	2.09	2.76	0.58	4.53	2.03	5.39		2.46	0.67	2.46	5.63	0.78	1.68	1.75	5.51	1.46	1.12	0.80	1.69	7.36	3.06
.000	.000	.000	.000	.000	.557	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
14.20	13.10	7.42	0.56	3.44	.000	2.60	4.35	4.52	16.00	4.48	2.20	15.00	4.46	11.40	4.62	8.22	5.42	.000	34.20		13.10	10.80	5.82	17.60	3.32	2.92	1.15	3.42	1.64	0.78	1.71	2.51	10.14	9.94
4.62	3.65	6.29	0.36	3.22	.000	0.87	1.21	3.43	8.50	4.00	1.92	5.96	3.70	7.98	4.44	6.29	5.31	.000	2.28		6.40	2.41	2.67	3.66	0.01	1.83	0.07	0.09	0.20	0.66	0.66	0.86	0.79	1.78
0.00	1.65	0.00	28.30	23.20	26.30	35.20	13.90	18.80	2.37	23.50	30.00	5.04	24.20	4.66	22.20	18.60	26.70	.000	.000		.000	16.80	.000	4.66	27.60	21.90	39.10	17.70	23.40	24.00	25.50	19.90	11.37	10.72
8.42	17.0	4.82	3.08	.000	.000	.000	1.64	1.88	11.80	.000	.000	12.80	.000	11.10	.000	.000	.000	.000	2.19		13.70	2.49	14.40	20.00	.000	.001	.001	.000	.000	.000	.000	.000	.881	6.048
6.70	6.71	4.05	1.96	.000	.000	.000	0.46	1.42	6.32	.000	.000	5.09	.000	7.72	0.05	.000	.000	.000	0.18		6.71	0.56	6.60	4.17	.000	.000	.000	1.40	.000	.000	.000	.000	.000	1.080

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